VOLUME XIX JULY, 1936 NUMBER 7

JOURNAL OF DAIRY SCIENCE

PUBLISHED BY THE
AMERICAN DAIRY SCIENCE ASSOCIATION

Contents

Abstracts of papers presented at annual meeting:

General Session 425
Production Section 428
Manufacturing Section 470
Extension Section 511

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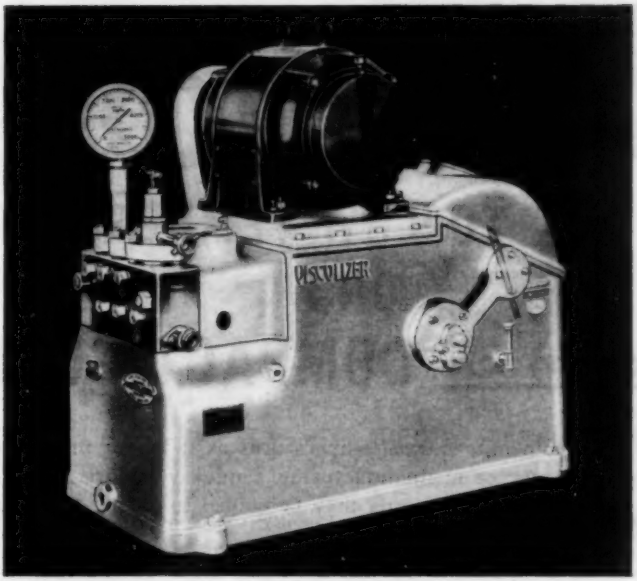

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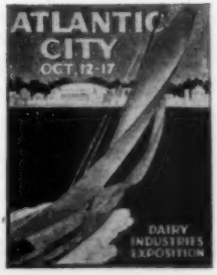

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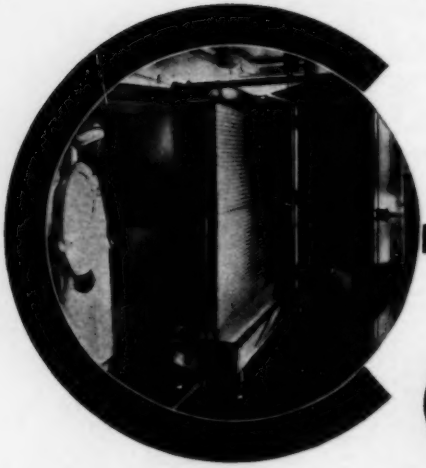

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The Journal of Dairy Science is issued monthly. Subscription is by the volume and one volume is issued per year.

Manuscripts should be typewritten and carefully revised before submission to A. C. Dahlberg, New York Agricultural Experiment Station, Geneva, New York. Twenty-five reprints will be furnished gratis to authors. Cost of additional reprints and reprint order blank will be submitted with proof.

Subscriptions. Price; $6.00 per volume in United States, Canada and countries within the postal union; $6.50 in countries outside the postal union. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume unless otherwise stated. Renewals should be made promptly to avoid a break in the series.

Subscriptions and Advertising should be mailed direct to the Science Press Printing Company, Lime and Green Streets, Lancaster, Pennsylvania.

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JOURNAL OF DAIRY SCIENCE

VOLUME XIX JULY, 1936 NUMBER 7

ABSTRACTS OF PAPERS PRESENTED AT ANNUAL MEETING*

GENERAL SESSION

Science and Practical Dairying. W. J. FRAZER, University of Illinois.

Uncle Sam keeps three immense dairy herds of 8,000,000 cows each. Since the average production of all these 24,000,000 cows is only 161 pounds of fat a year, this means, according to the spread in production of cows tested, that the upper third averages 220 pounds, the middle third 157 pounds, and the lowest third 106 pounds. Into the board and keep of the poorest two of these three huge herds goes the productive power of a larger area of good land than is covered by the states of Illinois and Iowa combined, as well as the money and energy of more than a million dairy farmers and their families.

Such facts as these should challenge every man connected with the dairy industry. The reasons for these conditions, as expressed by several of our best informed and most thoughtful dairymen, are that 90 per cent of the cows are so poorly and uneconomically fed and cared for that they are decidedly hindered at some time during the year in making their most profitable production. Two-thirds of the cows are not capable of producing 300 pounds of fat even if well fed and cared for. Ninety per cent of the dairy bulls now in use are not capable of siring 350-pound daughters if mated with dams of that capacity. Seventy-five per cent of the heifers are so poorly fed and cared for at some time during their raising that their efficiency as dairy cows is reduced.

What has the Dairy Science Association to do with preventing such an appalling waste of natural and human resources? The extension men and college teachers of dairy production are the connecting link between the fine research now being conducted and the dairy farmer. Unless these men keep in touch with scientific developments and then in some way get them into actual practice on the majority of our dairy farms, the balance-wheel of our whole Dairy Science Association is off center. Our extension men have already gotten the cows in our Dairy Herd Improvement Association herds up to an average of 317 pounds of fat a year, which is almost twice the average of the cows in the United States. Yet only about 2 per cent of Uncle Sam's 24,000,000 milk cows are in Dairy Herd Improvement Associations. What

* Authors have not corrected the proofs.

can the Dairy Science Association do to increase the production and profit from the other 98 per cent?

The National Survey of Sediment Testing of Cream and Butter. G. F. STEWART AND M. E. PARKER, Research Committee, American Association Creamery Butter Manufacturers.

This survey presents the preliminary results of a national investigation involving over 1,000 trials by creamery and agricultural college laboratories. The data have been collected and compiled according to the following state groups: (1) New York, Ohio; (2) Indiana, Illinois, Iowa; (3) Missouri, Kansas, Nebraska; (4) Michigan, Minnesota, North Dakota; (5) Kentucky, Tennessee; (6) Texas, and (7) California, Oregon. The data also are presented to show seasonal influences for Fall, Winter, and Spring months through May, 1936.

This national survey of methods determining sediment incream and butter indicates that—

(1) The milk sediment testing equipment can be used with satisfactory results, and that

(2) The Connecticut Official Milk Sediment Standards of 1931 can be used for interpreting results.

Of the eight different methods studied, at least two different methods for determining sediment in cream and in butter have been found to be satisfactory.

Notice: MEN Wanted! W. V. DENNIS, Pennsylvania State College.

This might be a sign of the revival of industry; right here it is a summons to very earnest thinking. One of the most tragic aspects of our restless present is our lack of faith in our leaders, industrial, financial, political, educational and religious. In the United States there are eight million youth, 18 to 25 years of age, out of work, three million of whom have never had a job. Even with this huge army to choose from the cry is going up on all sides, "We want *men*."

In industry, banking, trade and the professions employers are seeking *men*. Individuals with ample technical training and ability are plentiful; MEN are alarmingly scarce. The emphasis in selecting new salaried employees today is not so much on technical skill as upon personality, character, integrity, the will to accept and the capacity to carry responsibility.

This is a demand made alike of colleges and business institutions that reliable men be developed in the educational and administrative processes. This involves for many of us a new conception of our responsibility for the younger men who come under our influence. Modern ways of living, the character of the present day home, the tempo of life today and its prevailing poverty in spiritual dynamic make increasingly difficult the development of

the sort of men needed for these hours of crisis, these times of great economic and social changes.

The challenge of this demand for men is first to us who occupy in educational and business fields positions of leadership as administrators, counselors, experts in technique and as intellectual exciters. Is our equipment adequate for the task before us? What are our attitudes, and are they equal to the strain and stress involved in the inevitable adjustments? What is the nature of the human material with which we must work, and what of our methods of dealing with this material? Just what are our objectives? How far ahead are we seeing?

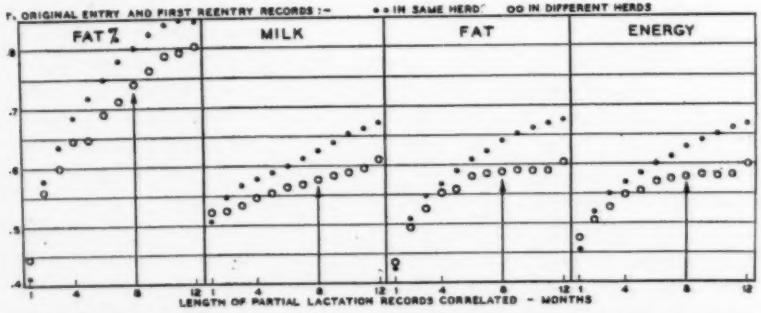
The future of the dairy industry, on the farm, in the manufacturing plant, and in the marketing mechanisms depends upon our ability and upon our willingness to meet the greatest need of our times, the developing of *men*. Upon us and upon men like us very largely depends the fate of western civilization. Notice: MEN Wanted! Can we furnish them? If so, How?

PRODUCTION SECTION

P1. Relative Genetic Worth of Partial Lactation Records of Various Lengths. W. L. GAINES, University of Illinois.

At the Cornell meeting in 1934 an energy-size index was proposed. It seems desirable to modify the terms of the index to "Calories of milk energy per kilogram initial live weight of cow per day for the first eight monthly tests of each lactation" (designated Cals./Kgs./Ds. or C-K-D, Proceedings American Society of Animal Production, 1935). C-K-D is a purely factual expression, in contrast to the fictitious nature of corrected records. It is a dynamic or metabolic measure of lactation, directly comparable between dairy cows of all breeds, and suited to biological analysis. In genetic analysis three mutually independent values are used: 1, live weight of cow or size of machine; 2, C-K-D or working efficiency of machine; 3, fat percentage or kind of work of machine. *Correction factors are avoided.*

It is the purpose of this paper to examine one point in the above plan, namely, the genetic worth of the 8-month record as compared to other lengths of partial lactation, where pregnancy is not a complicating factor. (The 8-month idea is not new, being used by Gowen as early as 1920, Genetics, and there is also the still earlier 8-months-after-calving 7-day Holstein system.) Material is drawn from the calendar-month original-entry and first-reentry records of Guernsey cows carrying a calf less than 5 months during the 365-day partial lactation. The correlations between the 2 records of the same cow are computed for the first full calendar month, the first 2 full calendar months, and so on to the first 11 full calendar months, and finally for the official 365-day record which usually embraces a partial month at start and finish. The coefficients (r) for 939 cows making both records in the same herd, and 237 cows making the 2 records in different herds are presented graphically.



Conclusion and Opinion. The r curve for fat percentage rises more rapidly with length of record than does the r curve for milk. This may be

linked with the number of tests rather than length of record as such, since the fat percentages are based on 1-day or 2-day samples each month, while the milk yields are based on scale weights of each milking. Where milk weights as well as fat percentages are based on 1-day monthly determinations, as in present common practice, the r curve for fat in the graph may be taken to represent the relative genetic worth of various lengths of record for farrow cows with respect to amount of yield. Whether the r curve for records in the same herd or the r curve for records in different herds is more representative is an involved question. The significance of differences in the r curves for milk, fat and energy is also an involved question.

Production should be recorded continuously as in the Herd Test plan. From the continuous records the first 8 monthly tests of each lactation may be used for genetic analysis. In the sire progeny chart as presented, the last three columns illustrate the data to be used for comparisons, either intrabreed or interbreed.

SIRE A

OWNER OF DAUGHTER	DAUGHTER AND DATE OF BIRTH	CALVING INTERVAL RECORD							FIRST 8 MONTHS (67 YEAR) RECORD						
		CALVED DATE	AGE YRS.	CALVING INTERVAL YRS.	IN MILK YRS.	DRY YRS.	MILK LBS.	FAT LBS.	INITIAL CONDITION SCALE 1-9	TOTAL FEED SCALE 1-9	MILKINGS PER DAY NO.	ENVIRONMENT SCALE 1-9	INITIAL LIVE WEIGHT LBS.	ENERGY-SIZE INDEX C-K-D	FAT PERCENTAGE %
A	A	33.907	1.91	1.07	.88	.21	5018	275	5	7	2.17	6	745	21.1	5.38
A	32.000	34.978	2.98	1.30	1.15	.15	9880	541	5	8	3.00	8	916	23.0	5.50
A	Z	34.926	2.51	.88	.80	.09	6056	365	6	7	2.33	7	800	27.6	6.07
A	32.419	35.806	3.39						5	6	3.00	8	888	24.5	5.98
									26 DAUGHTERS AVERAGE				812	25.1	5.81

P2. Heritability of Butterfat Percentage and Butterfat Production in the Data With Which Sires Have Been Proved in Iowa. JAY L. LUSH AND EARL N. SHULTZ, Iowa State College.

The first 355 dairy sires proved in Iowa had 2,385 daughters to be compared with dams. These data were studied, largely by correlations between daughter and dam within sire, to find how highly hereditary were butterfat percentage and total fat production. About one-half of the variance in percentage could be construed as hereditary in the simple additive manner. The corresponding fraction for total fat production was about one-fourth. The first 225 sires were proved with C. T. A. yearly records and the later ones were proved with lactation records. The C. T. A. yearly records showed the hereditary differences between the cows a little more clearly than the lactation records but the difference between the two kinds of records was far below the level of statistical significance. About one-sixth of the variance in test and about one-third of that in total fat production were caused by management or environment which were alike for all the cows in each herd but differed from herd to herd. Tentatively less than ten per cent of the variance in lactation length seems to be hereditary in the simple additive sense and only one-seventh of it seems attributable to general herd management or environment. From these findings the comparative accuracy of several kinds of progeny tests of sires is expressed both in pounds and in

terms of correlation, for future use again in the same herd or for future use in other herds chosen at random.

Forty-three per cent of all sires were proved with only five pairs of daughters and dams. Two-thirds were proved on six or less and only 9 per cent had more than ten pairs. As in most such studies, there was considerable regression from the dams toward the average level of the breed so that a majority of the daughters out of cows producing less than 400 pounds were better than their dams but as the dams' production rose above 400 pounds the percentage of daughters which were better than those dams decreased rapidly.

P3. Some Results of Eighteen Years of Close Breeding With Jerseys.
W. M. Regan, S. W. Mead, and P. W. Gregory, University of California.

In the spring of 1918, the purebred Jersey herd of the New Jersey Experiment Station, consisting of 3 bulls and 22 females, was entered on an experiment which had for its object the fixing of production through inbreeding and selection. Four years later these animals were combined with 29 Jerseys owned by the California Experiment Station at Davis. Since that time, no outside blood has been added. Sire to daughter matings are practiced. When necessary to replace a bull, his most highly inbred son, out of a cow possessing desirable type and production, was selected to take his place. The productive capacity of all females was determined in our own herd, while the transmitting ability of male offspring for both production and defects was determined in the herds of cooperating dairymen.

The following table gives the important facts concerning the transmitting ability of the original herd sires, as shown by the recent germ plasm survey made by the Bureau of Dairying. All daughters were tested; records were for 10 months, starting at 2 years of age.

	PAIRS	FAT PRODUCTION		CLASSIFICATION		
		Daughters	Dams	% fat	Lbs. milk	Lbs. fat
Pogis Torono Experimenter	26	411	403	Fair	Good	Fair
Rutgers Fern Napoleon	19	453	426	Fair	Fair	Good
Rinda Lad St. Mawes Lad	8	504	466	Good	Fair	Good
Octavias Rinda Lad	11	487	363	Excellent	Excellent	Excellent

Ten sons of these bulls have been proven in the herds of the cooperators. The results of 197 dam and daughter comparisons show an average increase, for the daughters, of 46 pounds of fat. The daughters of every bull have averaged better than their dams. The range of increase was from 21 to 103 pounds.

While production records have been obtained on some inbred animals carrying 75 per cent, and a few as much as 87.5 per cent of the blood of their sire, the number of such individuals is so small that reliable conclusions cannot be drawn. It can be definitely stated, however, that there has been no loss in body size or breeding efficiency.

The following simple recessive hereditary defects have appeared in the inbred stock: hairless, congenital blindness, and a form of acrondroplasia. A program designed to purge the herd of these defects is in operation.

P4. Evaluating Inheritance for Type from Grades Recorded in the Germ Plasm Survey. W. W. SWETT, Bureau of Dairy Industry, U. S. D. A.

Type grades for individual cows were recorded in approximately 400 of the reports of dairy herds submitted for analysis in connection with the Survey for Superior Germ Plasm recently conducted by the United States Department of Agriculture. The inheritance of individual sires was evaluated by assigning numerical ratings of 4, 3, 2, and 1 respectively to grades of Excellent, Good, Fair, and Poor, and comparing the average ratings of the daughters of the sire with that of their dams. The increase or decrease effected by each sire was expressed as a percentage of the maximum possible change, which is 3 points (4 to 1 or 1 to 4).

The evaluation of progress in establishing superior germ plasm for type in a herd involved the consideration of several factors such as (a) the proportion of the proved sires used that raised type-level, (b) the amount of improvement they effected, (c) the sequence of the superior and inferior sires evaluated, (d) the number of unproved sires, and (e) the extent to which female lines involved consecutive crosses to proved sires. Only herds having 2 or more proved sires (sires with at least 5 dam-daughter comparisons for type) were included in the herd-progress evaluation. Seventy-seven of the 228 herds meeting this requirement were listed as having shown some indications of progress in establishing superior germ plasm for type.

P5. Some Additional Findings of the Dairy Cattle Germ Plasm Survey. M. H. FOHRMAN, Bureau of Dairy Industry, U. S. D. A.

The discussion of the results of the germ plasm survey as given in the 1936 Yearbook of Agriculture includes a statement that the time limitation for the preparation of this material made it impossible to include data on all herds received after December 1, 1935. However, a considerable volume of material came in after that date. This was examined on arrival and those herds which showed evidence of some progress were passed along for analysis; while the balance were laid aside for later consideration. Some of the herds received earlier which showed only one proved sire were also held out of the original analysis.

This action which was made necessary by the time restriction may have slightly warped the results, particularly the analysis made of the relative numbers of sires in the various classes, and for this reason the herds which were laid aside were later studied in order to have a more complete picture of the entire field covered by the survey. An additional reason for completing the analysis of these herds was to afford their owners the benefit resulting from the assay of their herds.

This paper presents the results of the study of this group of herds and any effects which it might have on the reported findings already published in the Yearbook.

P6. A Report on a Control Program for Bovine Infectious Mastitis Based on Segregation of Infected Animals. E. O. ANDERSON AND W. N. PLASTRIDGE, Connecticut Agricultural College.

Observations on the incidence of streptococcal mastitis in seven experimental herds over periods of from one to five years are described. Data collected before and after the adoption of a program of segregation based on periodic examinations (chiefly bacteriological) and segregation of animals shedding streptococci identified as *Streptococcus agalactiae*, are presented.

The results obtained indicate that:

1. The annual rate of spread of infectious streptococcal mastitis in infected herds may be reduced 50 to 100 per cent by the use of the segregation plan described.

2. While the rate of spread of infection is materially reduced by segregating infected animals at one end of the milking string and milking them last, complete separation of infected animals is necessary to entirely prevent the spread of infection.

3. Herds free from *Streptococcus agalactiae* may be established by segregation of the normal animals; disposal of infected individuals, and replacement by first calf heifers that have not been exposed to infection following parturition.

The results obtained on a herd recruited from pregnant heifers are of particular interest, as tests made at monthly intervals since the herd was started in 1932 show that the animals have remained free from *Streptococcus agalactiae* up to and including the last test which was made April 6, 1936.

P7. Studies on Aseptically Drawn Milk from Bang's Disease Positive and Bang's Disease Negative Cows. H. B. MORRISON AND F. E. HULL, University of Kentucky.

During the past year a study on milk drawn aseptically from Bang's disease negative and Bang's disease positive cows has been carried on in two

commercial dairies in Kentucky. Samples were secured from each quarter of 184 cows, making in all a total of 711 samples.

Both of these herds contained both Bang's disease positive and Bang's disease negative cows. On one farm the positive and the negative cows were housed in separate barns and kept in separate pastures so they had absolutely no contact with each other. On the other farm two separate herds were maintained in one of which the positive and negative cows were not separated either in the pasture or in the barn, and in the other herd the positive cows were kept in a separate pasture but stabled at one end of the barn. They entered the barn through a separate door and had no contact with the negative cows although they were milked and fed by the same men that cared for the negative cows.

Four examinations were made on the milk aseptically drawn from these cows as follows: Brom Thymol Blue reaction; Leucocyte content; Agglutination test; and the examination for the presence of streptococci.

SUMMARY

1. A comparison of all four tests on the same sample showed the largest group among the positive cows to be positive to all four tests and the largest group from the negative cows to be negative to all four tests.

2. It appears from these results that cows positive to Bang's disease are subject to considerably more udder trouble than cows negative to Bang's disease.

3. The results secured from these herds indicate that proper care and management of herds containing Bang's disease positive and negative cows may influence the amount of udder trouble to a considerable extent.

P8. Two Types of Blindness in Cattle and Their Possible Relation to Vitamin Deficiency. A. H. KUHLMAN, W. D. GALLUP, AND EARL WEAVER, Oklahoma A. & M. College.

Two types of blindness have been observed in calves fed beet pulp, cottonseed meal, and bone meal. Calves receiving this ration are kept in a well-lighted barn and are usually fed whole milk for 45–60 days and then skim-milk to the age of six months. Beet pulp and cottonseed meal, fed in the ratio of one pound of pulp to 0.74 pound of cottonseed meal, were offered as soon as the calves would eat these feeds. Bone meal was fed at the rate of 10 and 20 grams daily per calf. As soon as low blood Ca or P values were obtained for any calf, it was exposed to direct sunlight or received aerated cod liver oil or viosterol or both sunlight and one of the vitamin D supplements.

The suitability of this ration for studies involving vitamins A and D is shown by the fact that when it is supplemented with 30 cc. of cod liver oil daily, calves have exceeded the normal rate of growth by 10 to 40 per cent

between the ages of six and twelve months. None of these calves has ever shown any indications of blindness or any other eye trouble.

One type of blindness which appears to be temporary usually occurs while the animal is losing weight. It has been cured by the administration of such vitamin A supplements as canned tomatoes, cod liver oil, and caratone. This condition is probably typical vitamin A opthalmia. It is associated with loss of appetite, bulging and watering of the eyes, grayish discoloration of the eyeball, ulceration of the eye, inflammation of the white portion of the eyeball, running at the nose, a rough, harsh coat, arched back, swollen joints, and convulsions. These symptoms usually appear when the calves are from 90 to 210 days of age.

The other type of blindness, which is permanent, apparently may occur simultaneously with the first, or may appear later or even when the animal is gaining in weight. In several cases it has also occurred independently, *i.e.*, in calves which have never shown vitamin A ophthalmia. This condition is less apparent by gross observation since the eyes appear to be normal and are not inflamed or discolored. The pupil, however, is always dilated. Blood analyses failed to show a deficiency of either Ca or P. One case developed even when the calf received 30 cc. aerated cod liver oil daily, indicating that vitamin D may not be involved.

Daily doses of 18,600 International units of vitamin A in canned tomatoes, 18,600 to 37,200 units of vitamin A supplied in caratone, (a crude extract of carotene), and 11,211 to 12,600 units of A supplied in cod liver oil, even when fed over long periods have not cured this type of blindness. The addition of 2,800 to 10,800 units of vitamin D in cod liver oil or viosterol in addition to sunlight also has not effected improvement in restoring sight. This investigation is being continued to determine whether or not this condition is due to constriction of the optic nerve.

It is interesting to note that of eighty-two calves from cows fed a ration of prairie hay and cottonseed meal, only one calf has been blind at birth. The eyes of this calf resembled the condition due to vitamin A deficiency, but became normal during the first week while nursing its dam. Thirty-nine heifers and ten bull calves have been raised on the basal ration of prairie hay and cottonseed meal and in no case has any calf ever developed blindness or other eye trouble. Apparently prairie hay contains the factor or factors which protect cattle against these two types of blindness.

P9. Production of White Spotted Kidneys in Calves. L. A. Moore and E. T. Hallman, Michigan State College.

When calves at 30 days of age are placed on a ration of skim milk, corn starch, bran, yeast, mineral or similar rations which are low in their vitamin A content, so-called white spotted kidneys develop in many of the calves. During the past four years some 30 cases have been noted of autopsy.

Macroscopically and microscopically the lesions are similar to those previously described which develop when colostrum is withheld from the new-born calf. The condition is also associated with the development of pneumonia and scours.

The calves usually come to autopsy at from 90 to 150 days of age. The feeding of carotene in the form of "caritol" seems to possess some preventative properties which would indicate that the condition may be related to vitamin A deficiency. Experiments are now in progress to establish the deficiency.

P10. Tuberculosis in Milk Goats. O. C. CUNNINGHAM AND L. H. ADDINGTON, New Mexico A. and M. College.

Since 1906 only five cows in the college dairy herd have reacted to the annual test for tuberculosis. Two of these reacted in 1929 and three in 1930. Post mortem revealed no visible tubercular lesions except in two cases of possible skin lesions.

Since 1919 the New Mexico Experiment Station has maintained a herd of milk goats for experimental breeding purposes. During the last decade the herd has usually contained about seventy individuals above six months of age. Since there is a wide-spread impression that goats are either immune or practically immune to tuberculosis and the presence of tuberculosis among animals is not general in the state, the goats were not tested for tuberculosis until 1931.

Two goats were removed from the herd as a result of the first tuberculin test. Both of these on post mortem showed pronounced tubercular lesions. Since 1931 five more goats have been removed from the herd as a result of applying the intradermal tuberculin test. One of these on post mortem showed pronounced tubercular lesions and three others minor lesions that may have been tubercular.

The authors feel that it is highly desirable that goats kept for the production of milk for human consumption be tested for tuberculosis the same as dairy cattle.

P11. Vitamin A Replaces Whole Milk in the Calf Ration. H. T. CONVERSE AND EDWARD B. MEIGS, U. S. Bureau of Dairy Industry.

In a paper read before this society in 1934 we concluded "that the whole milk in the calf ration is needed more for its vitamin A than for its fat or energy." The conclusion was based on the nearly normal six months' gains of a few calves getting only grain, hay, skim milk and a vitamin A supplement (cod liver oil or carotene) after three days on colostrum. The present paper gives additional evidence that it is not only safe to feed such a ration but that the gains in weight may be normal at thirty days as well as at older ages.

Our milk feeding schedule had been as follows: mother's milk for three days, Holstein whole milk to twenty days, a gradual change to all skim milk by thirty days, and the skim milk continued to six months. When the milk schedule was changed to all skim milk on the fourth day, the same amounts of skim milk, with its lower nutritive energy, were fed as of whole milk thus allowing much less energy during the first month.

Twenty calves, fed according to this skim milk schedule, have appeared quite normal and made about normal gains by six months although a few have made rather small gains and seemed somewhat undernourished during the first month. At twelve months of age, six heifers have made, on the average, almost exactly the expected gains in body weight.

Our skim milk schedule of feeding is now revised by increasing the amounts of it fed so that the claves get only slightly less nutrients from milk during the first month and slightly more during the second month than the old whole milk-skim milk schedule allowed. Five Holstein calves have been fed according to this increased schedule. With these calves, even the first month's average gain is greater than with those calves getting whole milk for the first twenty days.

P12. Supplementing a Normal Ration for Dairy Calves with Cod Liver Oil. P. M. REAVES, Virginia Polytechnic Institute, AND C. Y. CANNON, Iowa State College.

To study the effect of supplementing a normal ration for dairy calves with cod liver oil, two groups of four calves were used. The calves ranged in age from five days to sixty-four days, at the beginning of the trial. They were fed normally over a period of 139 days. At first whole milk was fed and later reconstructed skim milk. A concentrate mixture of corn, 4 parts; oats, 4 parts; linseed oil meal, 1 part; and wheat bran, 1 part, was fed, with good quality hay. The trial extended from January to May. The calves were in an open lot a part of the day when weather would permit. Both groups were handled and fed in the same manner, with the exception that the calves in the cod liver oil group received 20 cc cod liver oil daily until they reached a weight of approximately 200 pounds, at which time the oil was increased to 30 cc daily.

The results were measured by weekly weights and heights at withers. The blood of the calves was analyzed for calcium and inorganic phosphorus; the results of both groups were within the normal range. The calcium concentration was approximately the same for the two groups, while that of phosphorus was slightly higher for the cod liver oil group. The weight and height of all calves were equal to or above the Iowa normal (Ia. Bul. 154). The groups were very close in this respect.

The results of this trial indicate that the addition of cod liver oil to a normal ration did not benefit dairy calves.

P13. The Physiological Effect of a Hegari Fodder and Cottonseed Meal Ration on Dairy Cows. (Preliminary report.) O. C. CUNNINGHAM, L. H. ADDINGTON, AND EDITH M. LANTZ, New Mexico College of Agriculture and Mechanic Arts.

Twenty-one cows at the New Mexico Experiment Station were placed on a ration consisting of all the ground whole hegari plant they would consume—approximately 2¾ pounds per 100 pounds of live weight—and enough cottonseed meal to supply the additional protein requirements of the individual cows. Each cow was placed on the ration immediately after she had freshened. The milk production as compared with that during previous lactations when the cows received the regular herd ration was about 8 or 10 per cent less than the expected, after correcting for age.

One group of cows has received no suuplementary feed. One group received finely ground limestone (85% $CaCO_3$) at the rate of 2 per cent of the cottonseed meal. One group received Haliver oil as a supplement during their dry period, after completing the full lactation, and another group received Haliver oil following freshening at the beginning of their second lactation period. The twenty-one cows had produced thirty-five calves, all but two of which were apparently normal, before going on the experiment. Of the twenty-two calves born to these cows after being on the experimental ration and before any supplement was added, four have been classified as normal, four as weak, six as showing blindness or muscular incoördination, three as dying shortly after birth, two as dead at birth, and three abortions. Three of the cows that produced calves that were blind or calves showing muscular incoördination died shortly after the birth of their calves. Of three cows that received Haliver oil during their dry period, two produced normal calves and one a calf born during the night and found dead early in the morning under conditions that make the cause of death doubtful. Of the seven calves born of cows that received ground limestone, four have been classified as normal, one as weak, and two died shortly after birth.

Comparative feedings to rats (a) of butterfat from cows receiving the hegari and cottonseed meal ration and butterfat from those that received the regular herd ration, (b) of livers from calves whose dams received the hegari and cottonseed meal ration and from calves whose dams received the regular herd ration and (c) of livers from the cows themselves, all indicated a much lower vitamin A content of the substances from the cows receiving the experimental ration. A group of rats (one male, two females) placed on the experimental ration of hegari and cottonseed meal at weaning have produced no young up to nine and one-half months of age. A group receiving the experimental ration plus calcium carbonate has produced three litters containing nineteen young, and another group receiving the experimental ration plus Haliver oil has produced five litters containing thirty-one young.

Apparently the ration of cottonseed meal and the whole hegari plant is short in both vitamin A and calcium, and possibly other substances.

P14. The Vitamin A Requirements of Dairy Cows for Reproduction and Lactation Under Practical Conditions. EDWARD B. MEIGS AND H. T. CONVERSE, U. S. Bureau of Dairy Industry.

Groups of dairy cows, which were giving liberal quantities of milk and were free from infection with *Brucella abortus*, were fed for periods of several years on rations of grain combined with different kinds of hay. The average carotene contents of the various rations were determined approximately, and records were kept of the reproductive performance of the cows. On the rations containing the smaller quantities of carotene, there was a larger proportion of premature births, of still births, and of weak and blind calves. In the following summary, a calving is counted as normal if the calf was carried more than 269 days, was not blind at birth, and survived for 7 days or more.

On ration *I*, consisting of grain and U. S. No. 1 alfalfa hay, the average carotene content was approximately 26 parts per million, and the percentage of normal births, 91; Ration *V*, grain and U. S. No. 1 timothy hay; carotene, 8; normal births, 29 per cent; Ration *VII*, grain and No. 1 clover hay, light timothy mixed; carotene, 8; normal birth, 44 per cent; Ration *VIII*, grain and No. 3 alfalfa hay; carotene, 3; normal births, none; Ration *IX*, grain and No. 3 timothy hay; carotene, 3; normal births, none. The total number of calvings on each of the various rations varied from 6 to 22.

In other experiments it was found that the reproductive performance of cows on Ration *IX* could be greatly improved by supplementing it with such sources of vitamin A as carrots or cod liver oil, and that the reproductive performance of cows on Ration *V* was satisfactory if the cows were on this ration for not more than 6 months after a preceding period on pasture containing large amounts of carotene. Reproduction on Rations *VIII* and *IX*, however, was very unsatisfactory even after only five and a half months following a period on good pasture.

P15. Reproduction of Dairy Cows on a Ration of Prairie Hay and Cottonseed Meal. A. H. KUHLMAN, EARL WEAVER, AND ANDREW NALBANDOV, Oklahoma A. & M. College.

During the past few years considerable attention has been given to the importance of roughages of good quality in relation to reproduction in cattle. Results obtained in a study of the limitations of cottonseed meal in rations for dairy cattle over a nine-year period have consistently shown the value of Oklahoma prairie hay in protecting cattle against cottonseed meal injury. The breeding history of these cattle also shows that a ration of prairie hay and cottonseed meal fed to animals which have been kept in dry lot continuously has not impaired reproduction.

To date forty-seven different animals, all grade Jerseys, have been used in this study. Thirty-nine of these were started as day-old calves and eight were purchased when approximately a year old. The calves received whole milk for six weeks and then skimmilk until they reached the age of six months. Cottonseed meal and prairie hay were offered as soon as the calves showed a desire for these feeds. Excepting when cows were being "dried up," all animals have been fed approximately as much as each of these two feeds as they would consume. The animals have always been confined in dry lots. The eight heifers purchased as yearlings were fed and handled in the same manner as the other animals of the same age.

The results further confirm the earlier indications that on this restricted ration of only two feeds, cottonseed meal and prairie hay, no significant evidence of impairment of appetite or other physiological disturbances has ever become apparent during the periods of most rapid growth and development, and, further, that animals may be maintained satisfactorily for long periods of time on this ration. Thus far the available evidence continues to show that prairie hay when fed with cottonseed meal in the amounts indicated will protect cattle against so-called "cottonseed meal injury."

The results further indicate that the prairie hay used in this study, most of which was of average quality and for several years quite lacking in green color, supplied sufficient witamin A or other factors necessary for normal development and reproduction.

P16. The Effect of Sprouted Oats on Reproduction of Dairy Cattle.

H. P. Davis and I. L. Hathaway, University of Nebraska.

Considerable difficulty is often experienced by dairymen in getting virgin heifers as well as older cows to conceive. This condition is rather wide-spread, and it has been suggested that it may be due to a lack of vitamin E, although it seems that most dairy rations would have a fairly abundant supply of that vitamin. Winters and also Graves and Miller reported favorable results in feeding sprouted oats to cows that did not readily conceive. In 1931 tests were begun to determine the effect of feeding sprouted oats upon delayed pregnancy in dairy cattle. Two lots of ten virgin heifers were selected. Each lot was composed of one Guernsey, five Jersey, and four Holstein heifers balanced as nearly as possible with respect to age and relationship. As far as possible, the comparable animals of each lot were bred to the same bulls. Both lots were fed alfalfa hay *ad libitum* while in addition one lot received four pounds of sprouted oats per head daily. In the sprouted oats lot, six heifers became pregnant at one service, two required three services, one required four services and one required five services. In the chck lot six conceived at one service, one at six services. The tenth animal had to be disposed of after three services, but was not pregnant at that time.

Twenty-one services or 2.1 services per pregnancy were required for the sprouted oats group of ten animals. Twenty-one or 2.3 services per pregnancy were required for the no oats group of nine animals.

In 1932 a second trial was started. Two lots of virgin heifers were again selected. Each lot was fed alfalfa hay and silage. One lot received four pounds of sprouted oats per head. This amounted to about two pounds of unsprouted oats. The check lot received two pounds daily per head of dry whole oats. There were twelve heifers representing three breeds in the sprouted oats group, and ten heifers representing four breeds in the dry oats lot. In the sprouted oats lot, four conceived at the first service, two after two services, three after three services, two after four services, and one conceived following seven services. In the dry oats lot, five conceived at one service, two after two services, one after three services, one after six services, and one after eight services.

Thirty-two services or 2.6 services per pregnancy were required in the sprouted oats lot. Twenty-six services or 2.3 services per pregnancy were required in the dry oats lot.

The experiment was repeated in 1934. Both lots were fed alfalfa hay *ad libitum*. In addition, one lot was fed four pounds of sprouted oats daily and the other lot was fed daily four pounds of dry whole oats per head. The lots were balanced as previously, with four breeds represented. There were eleven heifers in the sprouted oats lot and eleven heifers in the dry oats lot. In the sprouted oats group, one animal conceived at the first service; two after two services; five after three services; two after five services, and one conceived after seven services. In the dry oats lot, three conceived after one service; one after two services; three after four services; three after five services; and one after eight services.

Thirty-seven services or 3.3 services per pregnancy were required in the sprouted oats lot. Forty services or 3.6 services per pregnancy were required for the dry oats lot.

For a period of about five years, 1926 to 1931, about six pounds of sprouted oats were fed to each cow and bull daily. While it is hard to draw any definite conclusions from such mass feeding where there were no check groups, an examination of the number of services required for conception for each cow during that period was substantially the same as the average for periods before and after.

It would seem, therefore, upon the basis of our experience that sprouted oats had no marked effect upon the reproductive functions of either heifers, cows or bulls as measured by the services required for conception.

P17. Magnesium Carbonate and Magnesium Oxide Supplements to a Whole Milk Ration for Dairy Calves. C. F. HUFFMAN AND C. W. DUNCAN, Michigan State College.

Several investigators have shown that calves fed a whole milk ration manifest tetany. We observed that the addition of cod liver oil or viosterol in sufficient amounts to maintain normal plasma calcium and inorganic phosphorus values failed to prevent the onset of tetany associated with subnormal plasma magnesium.

Twelve calves were used in the phase of the investigation reported in this paper. The basal ration consisted of whole milk, corn starch or rice crispies, viosterol, iron, copper, and manganese. Wood shavings or paper pulp were used for roughages. Calves receiving paper pulp in place of shavings manifest tetany associated with low plasma magnesium. There appears to be considerable variation in the magnesium requirement of calves. Fifteen to 20 mg. of magnesium as magnesium oxide per pound of body weight maintained plasma magnesium values and prevented the manifestations of tetany. Magnesium in the form of magnesium carbonate also maintained normal magnesium values.

Eight to 10 mg. of magnesium per pound of body weight from natural foods appeared to meet the magnesium requirement as indicated by plasma magnesium values.

P18. Gross and Microscopic Pathology Associated with Low Blood Magnesium in Dairy Calves. L. A. Moore, L. B. Sholl, and E. T. Hallman, Michigan State College.

During the past four years 35 cases of calves have come to autopsy in which the macroscopic and microscopic pathology was similar, indicating a definite syndrome. In all cases there was a previous history of low blood plasma magnesium.

Typical gross lesions were confined to the endocardium, blood vessels and diaphragmatic and splenic peritoneal surfaces. In milder cases the lesions were barely visible as slightly elevated light colored plaques 1 to 2 mm. in diameter and circular, oval or rather linear in outline. Larger more marked lesions were 2 to 5 mm. in largest diameter, variable in shape, rough and irregular on the surface and grayish white in color. In some marked cases the lesions were confluent over considerable areas. In one very extreme case the blood vessels were generally involved, and some of the smaller vessels showed marked generalized sclerosis. Many of the animals also showed variable degrees of pneumonia and nephritis.

The microscopic pathology of the white plaques noted in the macroscopic examination consists primarily of a hyaline like change which is generally basophylic when stained with alum-hematoxylin and eosin.

In the heart the lesions were confined principally to the connective tissue layer under the endothelial and subendothelial layers. In advanced cases changes have been noted in the myocardium including the Purkinje fibers.

In the larger arterial vessels in which the media consists principally of connective tissue elements, the lesions involved the media and the internal

yellow elastic membrane. In the smaller vessels where the media is made up principally of muscle cells, the lesions were confined principally to the internal elastic membrane.

The changes in the venous vessels involved the media principally, although where calcification had taken place there was erosion of the endothelium.

Microscopic lesions were present in most of the spleens examined involving the capsule and the elements of the trabeculae and in the pleural and peritoneal connective tissue elements of the diaphragm.

Extensive productive tissue changes with secondary atrophy of the parenchyma of the kidney were observed in some of these animals but whether they were related to a low blood magnesium or were due to other factors has not yet been determined.

In general the microscopic picture involved a basophylic hyaline like necrosis of the callagenous and yellow elastic connective tissue elements of the heart, blood vessels, spleen, peritoneal and pleural surfaces of the diaphragm. Further microscopic studies are in progress.

P19. Cod Liver Oil and Muscle Dystrophy in Calves. GEORGE DAVIS AND L. A. MAYNARD, Cornell University.

In view of the published observations in this laboratory that rather moderate levels of cod liver oil produce muscle dystrophy in sheep and goats, studies were initiated to ascertain whether calves are susceptible to this same injury. Calves around two to three weeks of age were divided into three groups to receive the same three levels of cod liver oil as had been used with the sheep and goats; namely, 0.1, 0.35 and 0.7 grams per kilo. The calves were reared on skim milk, grain and good-quality mixed hay, milk being withdrawn around four to five months. One calf on the highest level of oil died after 62 days showing external symptoms similar to those exhibited by the sheep and goats which died at this level, but no evidence of dystrophy was found on post-mortem examination. The growth of the other animals continued to be excellent. One animal from each group was killed at six months of age for post-mortem studies. None of these animals showed gross evidence of injury, but microscopic evidence of mild muscular dystrophy was found in the animals receiving the two higher levels of oil. The remaining calves, all of which continued to grow normally, were killed at nine months of age. No gross evidence of muscular dystrophy was found. The histological studies are in process and the results will be reported at the meeting. It is evident from the work to date that calves are at least much less susceptible to cod liver oil injury than are sheep and goats.

P20. Effect of Phosphorus Intake on the Calcium and Inorganic Phosphorus Content of Whole Blood of Dairy Heifers During the

Periods of Gestation and First Lactation. A. H. VAN LANDINGHAM, H. O. HENDERSON, AND G. A. BOWLING, West Virginia University.

The calcium and inorganic phosphorus content of the blood of two groups of Holstein heifers have been studied during growth including the periods of gestation and first lactation. One group was fed a normal phosphorus ration while the other was fed a ration low in phosphorus. Both groups received approximately the same amount of digestible crude protein and total digestible nutrients in proportion to body weight and the amount of milk produced.

The low phosphorus ration supplying an average daily intake of 11.8 grams of phosphorus (equivalent to 1.2 grams per 100 pounds of body weight) did not have any appreciable effect on the inorganic phosphorus content of the blood during the period of first gestation. The inorganic phosphorus of the blood showed a slight decline during the later months of pregnancy. There was a decided drop in the inorganic phosphorus of the blood at or immediately following parturition which was much more pronounced in the case of the animals on the low phosphorus ration. The amount of phosphorus in the feed, the total amount of phosphorus in the milk, and changes in the body reserve of phosphorus associated with gain or loss in body weight are factors which may affect the inorganic phosphorus in the blood during lactation.

The lower level of phosphorus intake, gestation, and lactation did not have any appreciable effect on the calcium content of the whole blood.

P21. Relative Utilization by Dairy Cows of Calcium and Phosphorus in Dicapho (dicalcium phosphate) and Bonemeal (tricalcium phosphate). J. A. NEWLANDER, H. B. ELLENBERGER, AND C. H. JONES, University of Vermont.

The utilization of Dicapho, a dicalcium phosphate and bonemeal, a tricalcium phosphate as mineral supplements were compared in balance trials with two pure-bred Holstein cows. These animals were fed a winter ration of timothy hay, corn silage and a suitable grain mixture, and a summer ration of timothy hay cut to one-half the usual amount, grass clippings in place of silage and a suitable pasture grain mixture. The daily allowance of mineral supplement was 100 grams. It was fed with the grain. This amount gave a large excess of calcium and phosphorus over needs. The trial ran for nearly two lactation periods, Dicapho being fed the first lactation and bonemeal the second. The milk yield of each of the rows ranged between 12,000 and 15,000 pounds per lactation.

In comparing the percentages of utilization of calcium and phosphorus in these mineral supplements it is necessary to consider the amount of intake and the amount of milk produced since the greater the intake, the lower

would be the percentage of utilization when an excess is fed and the greater the yield of milk the greater the opportunity for utilizing additional minerals for milk making over what could be stored in the body. Both of these factors favored the bonemeal rations.

With no allowance for the minerals in the excess milk and the difference in intake, the percentages of assimilation were materially higher for bonemeal than for Dicapho, the averages for the two cows being 6 per cent greater for calcium and 5 per cent greater for phosphorus. Allowing for the excess milk production when getting bonemeal, the percentage assimilation was still favorable to bonemeal by 3.7 per cent for calcium and 3.4 per cent for phosphorus. However, when allowance is made for both excess milk and amount of intake the percentage assimilation of calcium was 2.2 per cent greater for bonemeal but of phosphorus 1.1 per cent less for bonemeal than Dicapho.

Thus after making these allowances no very significant differences obtained in the assimilability of calcium and phosphorus from Dicapho and bonemeal when fed under the conditions of this trial.

P22. Body Analyses of Dairy Cows after Long Time Calcium and Phosphorus Balance Trials. H. B. ELLENBERGER, J. A. NEWLANDER, AND C. H. JONES, University of Vermont.

Three cows have been slaughtered and analyzed for their calcium and phosphorus content as a check on the results of long time balance trials.

Number 24, a pure-bred Ayrshire, though not on the balance trial herself, was analyzed as a preliminary step. She had been well fed in the University herd and at 9½ years went on a feeding trial. For one lactation she was fed timothy hay, corn silage or green grass, artificially dried grass clippings and a ½ grain ration, producing 7,025 pounds milk and 272 pounds fat. The next lactation she received a similar ration excepting that all grain was eliminated and the intake of hay and succulence reduced, these nutrients being replaced by those from dried grass clippings. She produced 8,530 pounds milk and 332 pounds fat. The ration in her last lactation consisted only of artificially dried Sudan grass, corn silage and only 284 pounds of dried grass clippings. She produced 8,610 pounds milk and 355 pounds fat. One month after her next calving she was slaughtered and analyzed.

Number 19, a pure-bred Holstein, was started on balance trial at six years and continued thereon for six lactations or a little less than six years. She was fed timothy hay, corn silage or green grass and a well balanced grain ration plus mineral supplements during all but the first year. In these six lactations she averaged to produce 13,930 pounds milk and 465 pounds fat. At the time of slaughter five days after calving she had accumulated positive balances of 5,123 grams calcium and 6,192 grams phosphorus.

Number 101, a pure-bred Holstein, went on balance trial when four years old. She was fed practically the same as Number 19 but without mineral supplements. She was on trial 2½ years, being slaughtered after milking 24 weeks in the third lactation, by which time her balances were –764 grams calcium and + 2,674 grams phosphorus. During the two full lactations and the 24 weeks of the third she produced 15,100, 14,300, and 10,060 pounds milk and 504, 498 and 336 pounds fat.

The following table sets forth results of the analyses for cows 24 and 19. Data for 101 will be available at the time this paper is presented.

Calcium and Phosphorus in Cow's Body

	WEIGHT KGMS.	GRAMS CA	% CA	GRAMS P	% P	RATIO CA/P
Cow 24						
Empty weight	449.0	7102.1	1.58	3676.6	.82	1.93
Contents of digestive tract	64.9	101.1	.16	106.6	.16	.95
Green bones	68.9	7026.9	10.20	3219.0	4.67	2.18
Fat-free empty weight	387.5	7102.1	1.83	3676.6	.95	1.93
" " green bones	54.8	7026.9	12.82	3219.0	5.87	2.18
" " soft tissues	297.9	72.6	.02	453.1	.15	—
" " hide and hair	38.7	8.7	.02	12.5	.03	—
" " carcass meat	211.2	37.4	.02	343.8	.16	—
" " blood	25.8	2.6	.01	4.6	.02	—
" " intestinal tract	34.6	24.4	.07	59.7	.17	—
" " other organs	13.4	2.1	.02	37.1	.28	—
Cow 19						
Empty weight	437.6	7775.4	1.78	4009.3	.92	1.94
Contents of digestive tract	63.6	80.3	.13	78.4	.12	1.02
Green bones	69.4	7668.4	11.05	3552.0	5.12	2.16
Fat-free empty weight	365.2	7775.4	2.13	4009.3	1.10	1.94
" " green bones	49.9	7668.4	15.37	3552.0	7.12	2.16
" " soft tissues	287.3	104.2	.04	453.6	.16	—
" " hide and hair	31.8	8.7	.03	9.4	.03	—
" " carcass meat	200.3	43.8	.02	339.6	.17	—
" " blood	28.1	2.8	.01	3.7	.01	—
" " intestinal tract	40.2	80.3	.20	78.4	.20	—
" " other organs	15.0	2.5	.02	35.8	.24	—
Cow 101						
Empty weight	371.4	6086.9	1.64	3476.5	.94	1.75
Contents of digestive tract	81.2	51.9	.06	60.2	.07	.86
Green bones	60.5	5983.6	9.89	2974.0	4.92	2.01
Fat-free empty weight	337.6	6086.9	1.80	3476.5	1.03	1.75
" " green bones	48.1	5983.6	12.44	2974.0	6.18	2.01
" " soft tissues	289.5	100.6	.03	496.5	.17	—
" " hide and hair	31.2	15.6	.05	18.7	.06	—
" " carcass meat	169.5	35.4	.02	348.0	.21	—
" " blood	24.4	2.8	.01	6.0	.02	—
" " intestinal tract	49.1	46.8	.10	83.9	.17	—
" " other organs	15.3	2.8	.02	45.9	.30	—

P23. The Influence of Roughage on the Vitamin D Potency of Milk.

G. C. Wallis and T. M. Olson, South Dakota State College.

Three lots of two grade Holstein cows each were used on this experiment. The cows were weighed monthly, fed according to the feeding standard, and exercised after sundown twice weekly in favorable weather. The grain mixture was made up of corn, oats, corn gluten meal, salt, and bone meal.

Starting with December 15 all the animals received beet pulp for roughage for two months to deplete them of vitamin D and standardize them for the experiment proper. Following this, two cows were continued on this ration for the check group, two were given 20 pounds of alfalfa hay each, and two others the same amount of prairie hay. Puratene, containing only one Steenbock unit of vitamin D in 8 grams was used to supply vitamin A to the check lot. The two lots of hay used were of similar curing history and of known vitamin D potency. The vitamin D potency of the milk was determined by running biological assays on the rendered butterfat from aliquot milk samples saved over 3 to 5 day periods. Fat samples were collected for preliminary trials in April, July and November previous to the beginning of the experiment proper and while the cows were receiving regular herd management. Another sample was obtained from all six cows after the two months depletion period. Additional samples were secured from each of the three groups after they had been on their respective experimental roughages for 30, 60, and 90 day intervals. Total calcium and inorganic phosphorus determinations on the blood plasma of the cows were made on three day composite samples at 30 day intervals. Two day aliquot samples of milk were also taken from each animal at 30 day intervals for fat, total solids, ash, calcium and phosphorus determinations.

The vitamin D assays on the preliminary samples taken while the animals were still under normal herd management showed that for one Steenbock unit it took 12.0 grams of the April fat, 3.2 grams of the July fat, and 9.6 grams of the November fat. The fat taken in February at the close of the two months depletion period was so impotent that healing was not initiated by the largest amount that the rats would consume. Neither was it possible to measure directly the vitamin D potency of the fat samples collected 30 days after the hay feeding was started. However, some of the rats receiving the highest level of fat from the alfalfa fed group showed slight healing, indicating that it might be more potent than the fat from the prairie hay group. This would harmonize with the observation that one Steenbock unit of vitamin D was contained in 3 grams of the alfalfa hay, whereas it took 6 grams of the prairie hay. Attempts are now being made to concentrate the vitamin D in alcohol extractions of the fat.

The blood analyses have been normal but for two exceptions. A heavy-milking cow on the alfalfa hay roughage has shown a decline in inorganic phosphorus to somewhat subnormal levels. One cow in the check group completed a lactation and freshened again after four months on the vitamin D deficient ration. She gave birth to a fine, vigorous calf, but two days after parturition she became paralyzed and was unable to get up. Blood samples taken at this time showed only 5.34 mgm. of calcium and 3.13 mgm. of phosphorus per 100 cc. of plasma. Two days after cod liver oil administration she was on her feet again and the plasma showed 7.77 mgm. of calcium and

3.66 mgm. of phosphorus per 100 cc. Milk samples were also taken at this time but have not been analyzed as yet. The other milk analyses have not varied appreciably from normal.

P24. A Further Study of the Factor in Soybeans Affecting the Vitamin A Value of Butter. J. W. WILBUR, S. M. HAUGE, AND J. H. HILTON, Purdue University.

It has been found in previous experiments that soybeans in rations of dairy cows have a suppressing action on the formation of vitamin A in the butter. It has also been found that the factor in soybeans responsible for this suppressing action is not affected by heat. Further experiments have been conducted for the purpose of determining what component part or parts of the soybean carry this factor.

When soybean oil, obtained either by expeller or solvent process was added to the check ration there was a marked suppression of vitamin A activity in the butterfat. Commercial soybean oil meal with relatively low fat content also contained the factor. Soybeans extracted with both ether and alcohol were somewhat superior to the expeller process soybean oil meal. An alcoholic extract of ether extracted soybeans did not contain the factor.

The fact that fat free soybeans still possess this active agent together with the fact that linseed oil had only a slight suppressing action on the vitamin A activity of the butterfat indicates that the soybean oil itself is not responsible for this suppressing action but that it is due to some other factor.

P25. The Rate of Change in the Vitamin A Content of Milk. W. C. LOY, J. H. HILTON, J. W. WILBUR, AND S. M. HAUGE, Purdue University.

Studies have been made of the rate of change in the color value, carotene, and vitamin A content of the milk from two cows following a change from a high vitamin A ration to a low vitamin A ration and vice versa. Alfalfa hay was the principal source of vitamin A in the high vitamin A ration, while timothy hay was the principal source of vitamin A in the low vitamin A ration.

When the cows were changed from the high vitamin A ration (alfalfa hay) to the low vitamin A ration (timothy hay) the color value, carotene, and vitamin A content of the milk dropped rapidly reaching an equilibrium for this particular ration in about 11 days after the change was made. When the cows were changed from the low vitamin A ration to the high vitamin A ration the color value, carotene and vitamin A content of the milk increased rapidly, reaching an equilibrium in about 10 days.

The results of these feeding trials would indicate that the major effect of a change in the ration upon the vitamin A content of cows' milk can be ascertained by relatively short feeding trials.

P26. Site of Synthesis of Fat in the Mammary Gland. PHILIP KELLY AND WM. E. PETERSEN, University of Minnesota.

Sections of mammary glands fixed in 10 per cent formaldehyde and physiologie saline solution were stained with dyes differentiating neutral fat and free fatty acids. Five such stains were used: Nile blue sulphate, neutral red, Osmic acid, Sudan and brilliant Cresyl blue. Sections were examined under high magnification and all methods were positive to free fatty acids in the basal part of the epithelial cell fading out toward the lumen. No evidence of free acids was found in the alveolus.

Ether and alcohol extract of the gland tissue indicated free fatty acid to the extent of 4 to 5 per cent of the total lipide extract of the gland tissue, calculated in terms of oleic acid.

The free fatty acids were isolated and the volatile fatty acids determined by the Reichert-Meissl method. These values were approximately twice that of normal butterfat.

P27. Galactin Content of Pituitaries. R. P. REECE AND C. W. TURNER, University of Missouri.

Investigations during recent years have indicated that the hormone, galactin, is the initiator of lactation. While there is no direct evidence indicating that galactin plays a part in maintaining lactation, there is indirect evidence upon this subject.

It was thought that additional information might be thrown upon the physiology of lactation by determining the galactin content of pituitaries. Consequently cattle pituitaries have been collected in a local slaughter house. One of us has always been present when the animals were slaughtered and data were recorded which enabled us to classify the pituitary glands according to the age, sex, stage of the reproductive cycle and stage of lactation of the animals. These pituitary glands have varied considerably in weight. The following table gives a summary of the weights of the glands.

While cattle pituitaries will enable us to study some of the factors influencing the galactin content of these glands it will be nearly impossible to obtain a sufficient number of pituitary glands at the most critical stages. For such additional information we have been working with a laboratory animal, the albino rat. We have been able to detect galactin in one normal male rat pituitary and at the present time we are studying the influence of estrone, thyroxine, pregnancy and lactation upon the galactin content of the rat pituitary gland.

TABLE 1

The weight of the bovine pituitary

GROUP	NO. OF GLANDS	MEAN IN GRAMS	MAXIMUM IN GRAMS	MINIMUM IN GRAMS
Fetal	30	0.0303	0.1656	0.0005
— to 140 days	19	0.0278	0.0726	0.0005
141 to 283 days	11	0.0623	0.1656	0.0060
Calf				
Up to and including 3 months	12	0.7361	0.9175	0.5900
4 months to and including 10 months	117	0.8941	1.3441	0.3412
Heifers—None included that were sexually mature	69	0.9005	1.3164	0.5969
Steers	30	0.8842	1.3441	0.5951
Bulls	18	0.8859	1.2694	0.3412
11 months to and including 23 months	74	1.1372	1.7666	0.6690
Heifers				
Open	34	1.1794	1.7666	0.7796
Pregnant	20	1.0733	1.4750	0.7434
Steers	14	1.1330	1.5082	0.6690
Bulls	6	1.1209	1.3469	0.9383
Cows—2 years and over	42	1.8193	2.7786	0.7431
Dairy	32	1.7820	2.7786	0.7431
Beef	10	1.9386	2.5389	1.3733
Open	30	1.8624	2.7786	1.1076
Pregnant	12	1.7115	2.3431	0.7431
Dry	22	1.6758	2.7786	1.1076
Milking	20	1.9771	2.6218	0.7431

P28. Bovine Ovarian Reactions to Various Gonadotropic Hormone Preparations. L. E. CASIDA, University of Wisconsin.

Heifer calves 1–3 months of age have been injected with various dosages of sheep anterior pituitary extract and pregnant mare blood serum. Table 1 summarizes the quantitative and qualitative responses of the calves' ovaries.

TABLE 1

Response of Holstein heifer calves to pregnant mare serum and anterior pituitary extract

NO. OF CALVES	HORMONE PREPARATION	TOTAL DOSAGE RAT UNITS	NO. DAYS INJECTED	AVG. OVARIAN WT., GMS.	CALVES SHOWING	
					Follicles only	Ovulation papillae
190	Normal uninjected			1.9 ± 0.09	.....	.....
7	P.M.S.	126 ± 30	6	5.9 ± 1.6	3	4
6	A.P.	50 ± 19	6	13.3 ± 4.5	6	0
3	A.P.	50–60	11–12	13.8	1	2

Five cc. of the hormone preparation were injected subcutaneously once daily and the ovaries were observed on the day following the last injection.

The data indicate that anterior pituitary extract does not bring about ovulation as quickly as pregnant mare serum, but the increases it produces in weight of the ovaries is greater with even smaller rat-unit dosages.

TABLE 2

Response of mature cows to pregnant mare serum and anterior pituitary extract

NO. OF COWS	HORMONE PREPARATION	TOTAL DOSAGE RAT UNITS	AVG. OVARIAN WT., GMS.
20	Normal uninjected		18.0 ± 1.2
2	P.M.S	32	15.7
13	A.P.	32	77.9 ± 10.5

The difference in quantitative response is also seen in the ovaries of mature cows which had been injected for four days and ovaries examined on the sixth day (Table 2). Thirty-two rat units of anterior pituitary extract gave 400% increase in the weight of the ovaries on the average, whereas the indications are that the equivalent dosage of pregnant mare serum produces little or no noticeable effect. The latter is in keeping with Hart and Cole's observation that 750 rat units of pregnant mare serum is an approach to a minimal dose to elicit a response in the mature cow.

P29. Comparisons of Arterial and Mammary Venous Bloods as Related to Milk Secretion. W. R. GRAHAM, JR.,* University of Missouri and National Institute for Research in Dairying, Shinfield, Reading, England.

Two methods by which arterial blood may be obtained for chemical comparison with mammary venous blood are described. The results from a large number of analyses of bloods taken from an artery and the mammary vein show that the time relationships of the two bleedings may influence greatly the values found for various constituents on analyses. These results indicate that certain fixed criteria must be applied in experiments of this nature if the results are to be interpreted as related to the process of milk secretion.

An attempt has been made to combine this type of experiment with measurements of the volume flow of blood through the mammary gland by the thermo strohmur method as a technique for study of the nutrition of the mammary gland. This is described and some results are given.

P30. Effect of Hypophysectomy on Development and Function of the Mammary Gland. E. T. GOMEZ AND C. W. TURNER, University of Missouri.

For many years the activity of the mammary gland has been assumed to be governed first by internal secretions or hormones of ovarian origin because

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of the relationship between mammary gland growth and reproductive activity and the repeated demonstrations of mammary gland growth following ovarian hormones (estrogenic and corpus luteum hormones) administration, and second by a secretion of pituitary origin as indicated by the experimental initiation of lactation in properly conditioned mammary glands by an extract of the hypophysis containing the lactation promoting principle. During recent years, however, the evidence accumulating in the studies with hypophysectomized animals seemed to indicate the existence of a reciprocal relationship between the pituitary, ovaries, and other endocrine glands in the control of normal growth and development and function of the mammary glands.

The daily injection of estrogenic hormones, theelin (aqueous and in oil) or the benzoate of dihydrotheelin in varying amounts ranging from 25 to 1000 I.U. on a number of hypophysectomized males and young female laboratory mammals in our laboratory, including the rat, mouse, guinea pig, and a single case of cat and rabbit for periods ranging from 20 to 90 days did not stimulate the growth of the glandular parenchyma. Likewise, daily simultaneous injections of 100 I.U. of theelin (in oil) and 1/5 rabbit unit of corpus luteum hormone for 20 days did not stimulate mammary gland growth in hypophysectomized young males and multiparous involuted female guinea pigs. In contrast to our observations, some investigators have reported the stimulation of mammary gland growth by the injection of estrogenic hormone alone and in combination with the corpus luteum hormone in hypophysectomized guinea pigs, rats and rabbits.

In experimentally cryptorchid and unilaterally castrated male guinea pigs carrying functional ovarian grafts from 6 to 8 weeks, the removal of the testis-grafts or the injection of lactogenic hormone, galactin, is followed by copious milk secretion within 48 to 60 hours. Hypophysectomy in this type of animals immediately before the injection of galactin, or at the time of the removal of the testis-grafts, prevented the initiation of lactation. Lactating female guinea pigs hypophysectomized at any stage during the lactation period declined rapidly in milk secretion, being completely dry in 2 to 3 days. Rats and mice hypophysectomized late in pregnancy or at any time during the lactation period either prevented the initiation or caused rapid decline and complete cessation of lactation. Daily injections of 10 to 50 mgs. of galactin immediately after hypophysectomy in lactating guinea pigs did not reinitiate the secretory activity of the mammary gland or prevent the rapid decline and cessation of lactation, respectively. Similar observations were obtained in three cats hypophysectomized during the lactation period. Lactation corresponding to the normal extent of the lactation period was maintained in guinea pigs by the daily injection of an aqueous suspension of ground whole pituitary gland of the sheep beginning at the time of hypophysectomy. Two goats giving an average of 3 pounds of milk daily declined

in production to 15 cc. on the second day after hypophysectomy. In one of these animals the injection of 100 mgs. of galactin administered twice daily for five days did not increase milk production. However, the production of both animals increased very slowly one week after the operation so that by the end of the second week they were giving from 150 to 200 cc. of milk daily which was maintained practically constant throughout the course of an observation period of about 3 months. At autopsy one of the animals was found to be incompletely hypophysectomized. While the level of production of these animals did not return to normal, it is evident that the fragments of pituitary tissue left were able to maintain the continuance of lactation.

These observations are believed to emphasize further the reciprocal pituitary-ovarian relationships with respect to the growth and development of the mammary gland and the importance of the products of other endocrine glands controlled by the hypophysis in lactation.

P31. The Vitamin A Content of A.I.V., Molasses and Normal Silage and the Effect of Feeding These Silages upon the Vitamin A Content of Milk. I. L. Hathaway, H. P. Davis, and J. C. Brauer, University of Nebraska.

A study was made of the vitamin A content of the A.I.V., molasses and normal corn silage. The silages were fed to groups of cows and the vitamin A content of their milk determined. The vitamin A determinations were made by feeding the silage or the milk to groups of rats whose body stores of this vitamin had been depleted by being fed a vitamin A deficient ration. Approximately 670 rats were used in these experiments. There were no apparent ill effects of feeding as much as 3.2 grams of A.I.V. silage per rat per day for 8 weeks. This was 20 to 30 per cent of the food consumed. The A.I.V. silage contained only slightly more vitamin A than did the molasses silage. The normal silage was decidedly inferior to either A.I.V. or molasses silage in vitamin A content.

Milk produced by cows receiving these silages as the only source of roughage ranked in the same order of vitamin A potency as did the silages namely, A.I.V. silage milk, molasses silage milk and normal silage milk. On the other hand when a good grade of alfalfa hay served as the only source of roughage, the vitamin A content of the milk produced contained more vitamin A than did the milk produced by cows receiving A.I.V. silage as the only roughage. When both alfalfa hay and A.I.V. silage were fed as the roughage and the amount of alfalfa hay consumed by the cows was less than that consumed by a comparable group on alfalfa hay and molasses silage, the vitamin A content of the milk produced was greater in the milk of the group receiving the molasses silage.

P32. Studies on A.I.V. Silage. Part I—Preparation and Feeding. C. F. MONROE AND C. C. HAYDEN, Ohio Agricultural Experiment Station, Wooster.

First cutting alfalfa, containing some clover and timothy, was cut into approximately inch lengths and run into a wooden silo. During the filling process a two normal mixture of hydrochloric and sulphuric acid was sprayed onto the cut material. Approximately 20 gallons of the acid mixture were added per ton of green material. Previous laboratory trials had shown that the acid should be added at this rate to obtain a desired pH of 3.5 in the resulting silage. The filling was completed on June 13, 1935. The silo was immediately "topped" by running in 2300 pounds of chopped green alfalfa (without acid), covering with tar paper, and finally with dry wood shavings to a depth of four inches. When the silo was opened on October 21 there were approximately 1000 pounds of spoiled material on top which was mostly non-acid alfalfa. The remaining silage proved to be of excellent quality with practically no spoilage and it has been quite palatable to the cows. The pH of the silage has averaged 3.67.

The original plan of this work called for cutting and feeding one-half of the field as A.I.V. silage and the other half as hay. However, due to heavy rains and poor curing weather, the hay crop was lost. It then became necessary to change the plan to the extent of comparing the A.I.V. silage with first cutting straight alfalfa, which was purchased.

The actual feeding work was conducted as follows: Group A, which consisted of 4 cows, was fed the A.I.V. silage as the only roughage, straight through the winter feeding period. Group B, which consisted of 4 cows was fed the first-cutting alfalfa hay, as the only roughage straight through. Groups C and D, consisting of 7 cows each, were used in a reversal trial. A.I.V. silage and first cutting alfalfa were alternated; while corn silage was fed in like amounts to both groups.

All cows received the same grain mixture fed in accordance with production. Finely ground limestone and a very small amount of potassium iodide were also fed.

The results of this trial in terms of milk and butterfat production and liveweight gains indicate that A.I.V. silage may be substituted for dry hay. In fact, the production was a little greater on the A.I.V. silage than on the hay ration. Most of this increase may be accounted for on the basis of a greater feed intake on the A.I.V. ration. The A.I.V. silage did not show any unusual milk-producing properties.

P33. Studies on A.I.V. Silage. Part II—Nutrient Preservation and Physiological Effects on the Cow. A. E. PERKINS AND C. F. MONROE, Ohio Agricultural Experiment Station, Wooster.

Samples of the crop taken at the silo averaged 33 per cent air-dry matter. Twenty (20) gallons per ton or approximately 1200 gallons of 2 N acid solu-

tion was added. The average air-dry matter of 10 samples taken throughout the winter was 30 per cent.

The pH of the acid solution added was 0.35; that of the juice draining from the silo, 3.29, and the average value for the silage was 3.67.

The total loss of juice (mostly measured) was 150 gallons or about one-eighth the volume of liquid added.

The total loss of crude protein in the juice was about 10 pounds or 0.17 of 1 per cent of the protein contained in the silage. The loss at the surface of the silo was only 1000 pounds after 4 months' summer exposure, although only a very simple seal of paper and wood shavings was used.

The silage was fed to one group of 4 cows as the sole roughage over a period of 160 days and to other groups of cows in connection with corn silage for shorter periods. Four (4) ounces of limestone was fed daily to each cow receiving A.I.V. silage.

The urine became much more acid in reaction. The bicarbonates practically disappeared and the ammonia increased from 10- to 150-fold.

The CO_2 capacity of the blood was decreased, but not to an alarming extent. This effect did not seem to be cumulative, and there was no noticeable effect on the condition or well-being of any of the cows.

Alfalfa hay fed in connection with the A.I.V. silage was much more effective in restoring the urinary reactions toward normal than was the ground limestone commonly fed for that purpose.

P34. Studies on A.I.V. Silage. Part III—Carotene Preservation, and Biological Properties of the Milk. W. E. KRAUSS AND R. G. WASHBURN, Ohio Agricultural Experiment Station, Wooster.

The average carotene content of the alfalfa in the field was 180 gamma per gram (air dry basis). By the time the crop had been hauled to the silo and chopped the carotene had dropped to 130 gamma per gram (air dry basis). Eleven determinations made as the material was fed out of the silo showed the A.I.V. to contain, on the average, 219 gamma of carotene per gram (air dry basis). The concentration of carotene in the upper part of the silo approximated that of the field samples, but as the bottom of the silo was approached the carotene concentration increased. That more carotene was found in the A.I.V. silage than in the original crop can probably be explained at least partly by the more complete extraction of carotene from acid-treated material. Hay made from the same field exposed to several rains contained about 22 gamma of carotene per gram (air dry basis). The preservation of carotene in the A.I.V. silage was, therefore, of considerable magnitude.

Samples of butterfat were obtained from the individual cows in the all-through and the reversal feeding experiments referred to in Part I. All the

samples were subjected to carotene determinations, using a Lovibond tintometer standardized against solutions of pure carrot oil. The carotene in the fats from two Jerseys and two Holstein in each of the feeding trials was determined spectrophotometrically.* From the results summarized in the following tables it is apparent that the carotene values for the roughages, obtained chemically, were reflected in the carotene content of the fat produced. The hay fed contained 7.2 gamma of carotene per gram and the corn silage 52 gamma per gram, both on an air dry basis.

Carotene concentration in butterfat produced by cows fed all hay or all A.I.V. continuously
(Mg. per Kg.)

COW AND BREED	BEGINNING	AFTER 30 DAYS	AFTER 63 DAYS	AFTER 120 DAYS	AFTER 150 DAYS
			All hay		
H 352	3.20	2.20	2.28	2.66	1.70
H 442	4.60	2.28	1.80	3.12	2.01
J 385	11.60	3.65	4.46	Dry	Dry
J 398	12.20	3.24	2.58	3.46	3.22
			All A.I.V.		
H 386	4.35	6.27	6.50	9.60	7.30
H 430	3.40	6.20	6.85	7.55	4.96
J 393	5.12	6.94	6.65	3.34(?)	Dry
J 477	10.08	9.97	8.20	10.05	6.86

Carotene concentration in butterfat produced by cows fed hay and corn silage or A.I.V. and corn silage and reversed
(Mg. per Kg.)

COW AND BREED	BEGINNING	END OF FIRST PERIOD	END OF SECOND PERIOD
		Hay	*A.I.V.*
H 346	3.08	3.14	7.48
H 465	2.12	2.57	5.44
J 427	4.32	2.02	11.75
J 453	1.59	3.36	7.44
		A.I.V	*Hay*
H 343	4.84	6.05	3.04
H 476	?	5.85	2.74
J 373	3.22	8.60	2.12
J 435	4.52	8.05	4.32

Milk from the all-through groups was mineralized and fed to pairs of rats, one rat of each pair receiving milk from the A.I.V. cows and one milk from the hay cows. Very slightly better responses were obtained with A.I.V. milk

* Courtesy of the S. M. A. Corporation, Cleveland, Ohio.

in three series involving 20 pairs fed according to the paired feeding system and 8 pairs fed ad libitum.

Milk from the hay cows was found to contain more vitamin D and somewhat more of the vitamin G complex. No difference was found in the vitamin C content of the milk produced on the various rations. The surplus of vitamin C obtained from A.I.V. silage was excreted in the urine.

P35. Photographic Techniques as Applied to the Dairy Industry.
R. F. MORGAN, University of Nebraska.

The standard of photographic illustrations in most of our scientific magazines is low. A recent survey of nearly 4,000 photographs which appeared in medical journals showed that 24% of the illustrations were poor; 34% were only fair and 42% were good or excellent. The photographs were of low standard because many of them were taken by workers who had little or no knowledge of the principles of photography. As a result much loss of detail was encountered in the preparation of cuts.

Good photography, regardless of the profession, requires a thorough understanding of the mechanism of the camera in use, unlimited patience, a broad knowledge of photography and the skill to apply the information to the subject.

Photography of a technical nature is usually made by artificial light or under adverse conditions so it is often difficult to get good results. Failure may be due to many conditions. The use of an inferior lens may cause distortion of the subject, spherical abbreviation, chromatic abbreviation or some other fault of this nature. Failure to obtain good photographs is often due to lack of critical focus on the subject. Or it may be due to under exposure. The use of a high grade light meter will greatly improve the quality of all kinds of photographs. Satisfactory tones cannot be produced without an understanding of the use of light. Correct lighting will give depth and modeling to an otherwise flat picture. Avoid including too many objects in one picture. Simplicity is always an important point to consider in composing the picture. For exposures over 1/25 of a second, the camera should be placed on a substantial tripod or on some solid base to avoid vibration.

There are many applications of photography in dairy science. One very practical application in vitamin D assay work has been developed in the Department of Dairy Husbandry at the University of Nebraska. Longitude sections of tibia bones from rats having received vitamin D milk or bread are photographed through a specially constructed camera. The rat bones can be enlarged seven to eight diameters and eight sections of rat bones occupying a space approximately one inch long by three-fourths inch in width can be enlarged to fill a 5×7 film. By this method the bones can be photographed direct without enlarging from a small negative.

The original camera for this work has a double bellows extension twenty inches in length from lens to film. To this camera is attached a wooden box 38½ inches long. This gives a complete bellows extension of approximately 58″ from lens to film. It has also been necessary to arrange masks inside the wooden box to prevent reflections. Fine detail can be obtained in the enlargement of small objects by the use of this technical camera.

The use of photography in the breeding program and in the studies of growth at the University of Nebraska in their herd of dairy cattle has also proven to be a valuable asset in studying the progress made in these lines of endeavor. Animals are photographed monthly and all pictures are taken on the same scale against a barred background. The pictures obtained by this system are an excellent source of information which could hardly be presented by any other method of record keeping. When the animals are properly posed records of this nature afford an indisputable story of the growth and appearance of the animals from infancy to maturity.

P36. Alignment Charts for Estimating Profit Per Cow and Per Unit Milk. S. Brody and A. C. Ragsdale, University of Missouri.

About a year ago we published an alignment chart for estimating the energetic efficiency of milk production, that is, the percentage ratio of energy in milk produced to energy in TDN consumed (see Missouri Station Bulletin 351). Energetic efficiency of milk production is the best index of dairy quality or "productive efficiency" inasmuch as it is independent of extraneous circumstances such as size of cow, prices of milk and feed, etc. However, a demand developed for a similar chart for estimating profit, and it is the purpose of this paper to present two kinds of such profit charts.

Both of these are called alignment or nomograph charts, the construction of which is too technical for discussion at this time. However, the use of the charts for estimating profit is simple. A numerical example is written out on each chart and the method of solving it is indicated by broken guide lines.

To use the first and apparently simpler chart, it is first necessary to evaluate energetic efficiency of the cow by the method given in Missouri Station Bulletin 351. Knowing energetic efficiency, milk production, feed and milk prices then profit per 1,000 pounds FCM and per cow is read from the chart as illustrated by the numerical example thereon, and indicated by the broken guide lines.

To use the second and apparently more complicated chart, it is not necessary to have the energetic efficiency. Only live weight, milk production, prices of milk and TDN are needed to estimate profit.

In both cases, the milk of the given fat per cent must be converted to Gaines' FCM (4% milk) before carrying out the estimation. (Missouri Station Bulletin 351 presents a simple method for making the conversion from milk to FCM.)

P37. A Lesson in Feeds. R. B. BECKER, University of Florida.

Study of feeds is simplified by classing them into groups that have common characteristics. This plan saves time in study to fix in mind the nutrient qualities of feeds. Such a method was presented in Oklahoma Extension Circular 246, patterned after earlier publications and has been used in "Feeds and Feeding" classes. The text "Feeds and Feeding," by Henry & Morrison, is supplemented with bulletins and selected references. Each student is supplied with a paper 17×22 inches on which he enters headings regarding chemical composition (Appendix Table 1), coefficients of digestibility of dry matter (Table 2), the digestible crude protein and total digestible nutrients (Table 3), net energy value in therms (Table 6), and average calcium and phosphorus *percentages*, supplied subsequently by the instructor.

In the left column, each student lists certain major classes, and allows for 3 or more feeds under each, and average values for each class of feeds. This suggested classification follows:

Concentrates

Starchy grains and seeds—No. 2 corn, oats, barley
High-protein oil seeds—cottonseed, flax, peanuts, soybeans
Industrial and milling by-products—bran, corn gluten meal, beet pulp, etc.
High-protein oilmeals—cottonseed, linseed and soybean oilmeals
Molasses—blackstrap
Animal by-products—skimmilk powder, tankage, fishmeal

Bulky Feeds

Grass hays—timothy, Sudan, natal grass
Legume hays—alfalfa, cowpea, peanut
Low grade roughage—oat straw, corn cob, cottonseed hulls
Silages from grasses—corn, sorghum, sugarcane
Silages from legumes—soybean, peavine cannery silage

Root Crops—mangles, turnips, potatoes, sweet potatoes

Each student fills in his chart from the tables designated and the additional references. When the chart is completed, he receives a set of study questions which constitute a regular examination. Typical questions include:

1. Compare the composition of starchy grains with high-protein oil seeds. How do these differences affect their use in rations?
2. Rank the groups of feeds from low, to high, in fiber content.
3. What relationship appears to exist between percentage of fiber and coefficient of digestibility of dry matter in starchy grains, grass roughages and root crops? With which group may the dry matter of root crops have a similar feeding value?
4. In general, how do concentrates compare with roughages in T. D. N. values?

5. Explain possible causes of lower net energy value per pound of T. D. N. in low grade roughages, as compared with grass hays and with starchy grains.
6. Explain the high T. D. N. value of the high-protein oil seeds.
7. Are grass and legume hays similar in feeding value to silages from similar crops, when calculated on a dry matter basis?

Use any accessible reference in answering these questions.

To round out use of this chart, Kellner's calcium and phosphorus standard for dairy cows is used when estimating adequacy of rations in these elements.

Placing feeds in classes for combined study facilitates an understanding of the characteristics and nutritive properties of individual feeds, and brings local feeds and feeding problems into closer relation with established general practices.

P38. Production of Dairy Cows when Fed only Silage and Cracked Soybeans. N. K. WILLIAMS, C. Y. CANNON, AND D. L. ESPE, Iowa State College.

Four pairs of dairy cows in the early stages of lactation were selected from the station herd and divided into two lots consisting of one cow from each pair.

After a ten-day transition phase one lot was put on a ration consisting of silage fed *ad libitum* and cracked soybean grain fed at the rate of approximately one pound for every five pounds of milk produced. A mineral mixture composed of equal parts of steamed bone meal and common salt was available at all times. The other (check) lot was fed a standard ration of silage, alfalfa hay, and a grain mix made up of 4 parts yellow corn, 4 parts oats, 1 part soybean oil meal, 1 per cent salt and 1 per cent bone meal, and fed at the rate of approximately one pound of grain for every three pounds of milk produced.

During the five months of the trial both lots of cows were in good health and produced milk and fat at about the same rate. The fat tests of the experimental cows were normal except for a short period at the beginning of the trial when milk production was a trifle low and the fat test correspondingly high.

Chemical analyses of periodic samples of milk taken from the two lots showed that the iodine number of the fat from the cows fed silage and soybean grain had a mean of 40 as compared to a mean of 30 for the fat from the check lot. Likewise, the Polenski number was about 2.3 as compared to 3.3 for the fat from the check lot. The Reichert-Meisel values fluctuated somewhat, but the averages for the two lots were about the same. The protein values of the milk produced by the two lots showed no particular change from each other.

P39. Methods of Making Grass Silage. T. E. WOODWARD, Bureau of Dairy Industry, U. S. D. A.

The objects of this work were to find the methods best adapted for making grass silage in ordinary tower silos. Answers were sought to the following questions: Should the grass be chopped before it is placed in the silo? What is the influence of the moisture content and of the maturity of the crop upon the quality of the silage? Can grasses that ordinarily make a poor quality of hay be better utilized by putting them in the silo? What are the advantages, if any, of adding dilute acids or molasses to the material as it is placed in the silo?

The efficiency of the different methods was determined by the quantity which could be put in a silo of a given size, the extent of spoilage, the loss of nutrients, the temperatures attained, and the appearance, odor and palatability of the silage.

Wooden stave silos 4 feet in diameter and 8 feet high were used. In order to more nearly simulate conditions in a deeper silo, weight was always applied as soon as the filling was completed. This weight was at the rate of 40 to 45 pounds per square foot of surface. Altogether 19 fillings in the last 3 years are represented in this study.

Chopping permits more material to be stored in a given space, reduces the spoilage, and makes the silage more palatable. Partial drying makes the material easier to handle, increases the quantity of dry matter that can be stored in a given space, does not impair the palatability, but may increase the surface spoilage. Immature grass makes a better silage than more mature grass. Unpalatable grass will not make a palatable silage. Good grass silage is quite palatable; cows will eat as much of such silage as they will graze of the grass from which the silage is made. Exclusive of surface spoilage, the losses of dry matter are very small. The preservation of protein appears to be almost perfect. Grass silage properly made has a high content of carotene. With fine cutting and close packing the temperatures can easily be kept well below 100° F. The addition of acid may reduce slightly the loss of carotene, but on the other hand, it may affect the palatability adversely. It is not believed possible for the acid to bring about sufficient improvement to justify its use. A single trial with the addition of molasses fails to disclose any particular advantage in using molasses. Unlike acid, however, molasses does furnish valuable food nutrients, and it is not destructive to clothing and to the silos themselves.

P40. Sweet Potatoes Versus Silage for Milk Production. R. H. LUSH,* Louisiana Agricultural Experiment Station.

Having in mind the small Southern farmer with too few cows for any type of silo, but with facilities for raising more sweet potatoes than necessary

* Credit is due Superintendent Sidney Stewart, North Louisiana Experiment Station, for aid in the first and fourth tests, and Professor C. H. Staples, Louisiana State University, for the second and third tests.

for home use, we have been making feeding reversal tests with potatoes and silage. Chopped sweet potatoes were fed at the rate of two pounds per hundred pounds live weight. Silage was fed at twice that rate. The same kind of high protein grain and hay has been used. Jersey and small Holstein cows were used. Results are given in terms of four per cent fat corrected milk.

In the first test, a net increase of 10.3 per cent milk was obtained for sweet potatoes over sorgo silage in two 35-day periods. Two hundred and forty pounds of silage were required to equal 100 pounds of sweet potatoes. With silage at $4.00 per ton, this gives a feed replacement value of $9.62 for sweet potatoes. In a second comparison which covered two 30-day periods, an increase of 10.4 per cent milk was obtained for the sweet potatoes over corn and soybean silage, and 256 pounds of silage were required to equal 100 pounds of sweet potatoes. In a third comparison, also with corn and soybean silage, sweet potatoes produced 5.62 per cent more milk during two 40-day periods. One hundred pounds sweet potatoes replaced 258 pounds of silage. In the fourth test, sorgo silage was used again for two 50-day periods. A part of the potatoes were frozen and quality impaired during the latter part of the test. However, 1.37 per cent more milk was produced during the sweet potato periods.

The average of the four tests gave 6.93 per cent increase, or 2.08 pounds more milk per cow daily for sweet potatoes than for silage, indicating that slightly more than 250 pounds of silage were required to equal 100 pounds of sweet potatoes. Butter churned from the first two tests showed higher color for the period of sweet potato feeding than for silage feeding. There were no noticeable ill effects on flavor of milk and butter or health of cows due to feeding sweet potatoes. When the grazing value of sweet vines (under investigation) is included, sweet potatoes are not only satisfactory, but are also economical as a dairy feed on many small farms.

P41. Soy Bean Hay as the Sole Roughage for Dairy Cows. L. F. Herrman and G. A. Bowling, West Virginia University.

Two trials were conducted to determine if soy bean hay as the sole roughage in the ration is as efficient as soy bean hay and corn silage. The single reversal method was used, and the length of the periods was forty-five days in one trial, and thirty in the other. Ten cows were used in one trial, twelve in the other. The check ration contained a grain mixture of corn, oats, wheat bran and cottonseed meal, while the trial ration for the first trial contained a grain mixture of corn, oats and wheat bran, and in the second trial a grain mixture of corn and oats only. The rations supplied approximately equal amounts protein and total digestible nutrients.

The average daily milk production during both trials was 30.7 pounds of 4 per cent milk per day per cow when the check ration was fed, and 30.5

pounds per day when the soy bean hay was the sole roughage. The difference in loss or gain in weight on the two rations was not significant.

P42. Limited Grain Feeding of Dairy Cattle. C. E. WYLIE AND L. R NEEL, University of Tennessee.

This experiment was started in February, 1933, and is still in progress at the Middle Tennessee Experiment Station, Columbia, Tennessee. There are two groups, of seven cows each, of registered Jerseys which are fed rations as follows:

Group I. (Full grain)
Alfalfa hay ad libitum
Corn silage, 3 lbs. per 100 lbs. liveweight
Concentrates, 1 lb. to 3 lbs. milk
Pasture* April to October inclusive

Group II. (Half grain)
Alfalfa hay ad libitum
Corn silage, 3 lbs. per 100 lbs. liveweight
Concentrates, 1 lb. to 6 lbs. milk
Pasture* winter and summer (weather permitting)

The results to December 31, 1935, show the following.

I. The half grain group not only consumed considerably less concentrates but also less hay and silage than the full grain group.
II. The full grain group produced more milk and butterfat than the half grain group.
III. The feed cost per pound of butterfat and per hundred pounds of milk was lower on the half grain group.
IV. The income over cost of feed was approximately the same for each group, with the half grain group slightly greater.
V. The half grain group were on pasture 1015 days while the full grain group were on pasture 610 days during the total time of 1048 days.
VI. The type of farming for the two groups is significantly different.

P43. The Value of Grinding Grains for Lactating Dairy Cattle. A. L. DARNELL, Texas A. & M. College, AND O. C. COPELAND, Texas Agricultural Experiment Station.

Experiments are reported concerning the value of grinding grains for dairy cows. Comparisons were made on whole vs. ground milo, whole vs. ground oats, whole vs. ground barley and whole vs. ground corn.

* Pasture included bluegrass, lespedeza, and Sudan grass in midsummer. The remainder of the year it included barley and rye in addition to bluegrass.

In all of the experiments there was a greater production of milk during the periods of ground grain feeding which was accompanied by a greater consumption of concentrates. In the experiments with corn and oats the increased milk production during the periods of ground grain feeding could be accounted for by the greater consumption of concentrates, and there was only a slight difference between whole and ground milo which could be attributed to grinding. However, with barley there was a very significant difference favoring grinding. Increased milk production favoring grinding was much greater with high producing cows than with medium or low producers. More small grain such as milo will pass through the cow unmasticated than the larger grains such as corn. Very little nutriment was removed from any of the whole grains passing through the cow's digestive system.

P44. The Feed Value of Oat Mill Feed as a Hay Substitute for Dairy Cows. A. W. LATHROP AND G. BOHSTEDT, Wisconsin Experiment Station.

The experimental results given in this summary were obtained from feeding trials with dairy cows at Monona Farm, the livestock feed research farm of the Quaker Oats Company, where the feeding experiments with oat mill feed were under the direction and supervision of the Wisconsin Agricultural Experiment Station.

Oat mill feed is a by-product of the manufacture of oat meal. It is a finely ground mixture of about 85 per cent oat hulls and 15 per cent oat shorts and oat middlings. Seventy-one samples of oat mill feed, taken over a period of as many months, gave an average composition of $5.5 \pm .08$ (σ) per cent crude protein, $27.9 \pm .12$ per cent crude fiber, 1.7 per cent fat, and 6.4 per cent ash. Some of the more important ash constituents and their amounts contained in oat mill feed are: Silicon 2.43 per cent, calcium 0.069 per cent, and phosphorus 0.148 per cent.

A large number of feeding experiments with oat mill feed have been completed during the last nine years but only those in which oat mill feed was compared with timothy and alfalfa hay for lactating dairy cows are considered here.

Oat mill feed was compared in double reversal feeding trials, and in hay, silage, and suitable concentrate rations: With timothy hay in three trials; with alfalfa hay in two trials; and with alfalfa hay, 50 per cent replaced, in three trials.

Weight changes in comparable lots were about the same, and calculated on a feed replacement basis for the production of standardized milk, oat mill feed was worth about 95 per cent as much as U. S. No. 1 timothy hay and fully 70 per cent as much as uniformly high quality alfalfa hay in

these short time double reversal experiments lasting 147 days. In the cases of growing animals, longer feeding periods, and otherwise less favorably constituted rations, a lower value would be expected. This is simply in recognition of the minerals, vitamins, and superior proteins of high quality hay.

P45. Milk and Butterfat Yields of Holstein Cows on Rations Restricted to Roughage. J. R. DAWSON AND R. R. GRAVES, Bureau of Dairy Industry, U. S. D. A.

For several years the Bureau of Dairy Industry of the United States Department of Agriculture has conducted experiments at their field stations on various phases of improving roughages for dairy cattle feeding. The purpose of one important phase of these experiments has been to determine the level of milk and butterfat production that can be expected from cows when their rations are restricted entirely to high quality roughages for entire lactations. No grain is fed. To date 46 Holstein cows of more than average producing ability have completed 62 lactation period records when fed rations restricted to different roughages, according to the following groups:

Group 1. Twenty-three cows made 29 records when fed alfalfa hay and corn silage ad libitum and pasture.

Group 2. Fifteen cows made 24 records when fed only alfalfa hay of good quality.

Group 3. Four cows made 5 records when fed pasture grass hay which was cut at an early stage of maturity.

Group 4. Four cows made 4 records when fed only silage made from pasture grass cut at an early stage of maturity.

The 46 cows also made records under full feed conditions whereby they received alfalfa hay, silage, and pasture, and a grain mixture was fed at the approximate rate of 1 pound of grain to each 3 pounds of milk produced. Care and management conditions were similar for all groups.

Average milk and butterfat production between the 4 groups on the respective kinds of roughages was remarkably close, as was the comparative production under full feed conditions. The 62 records on roughage alone averaged 11,416 pounds of milk and 405 pounds of butterfat, age corrected. Under full feed conditions the average production (age corrected) was 18,746 pounds of milk containing 654 pounds of butterfat. The average production on roughage alone was 61 per cent in milk and 62 per cent in butterfat of the average production made under full feed conditions. The records made in Group 1 where pasture formed a part of the roughage averaged 7 per cent higher than the records made in the other 3 roughage groups that received no pasture.

Feed and nutrient consumption and other records bearing on a proper interpretation of the data are presented and discussed.

P46. Some Results of Eight Years of Investigation Concerning the Rôle of Roughage in the Diet of Ruminants. S. W. MEAD AND HAROLD GOSS, University of California.

Having shown that the failure to secure normal growth of dairy males reared on a ration devoid of roughage, results principally from a deficiency of vitamin A, a second experiment was conducted to determine the effect of such a ration on lactation and reproduction, in addition to growth.

Three groups of grade Holstein heifers, on experiment at two days of age, were fed, in addition to milk, to 4 months of age, as follows: Group 1, the basal ration consisting of concentrates, NaCl, and cod-liver oil; Group 2, the basal ration, plus calcium carbonate; and Group 3, the basal ration plus calcium carbonate and paper pulp. The animals were kept muzzled except when stanchioned for feeding.

There was no difference between the results obtained from any of the groups which could be attributed to the experimental procedure.

Skeletal growth was normal. Increase in body weight and milk production following first calving were subnormal because of insufficient nutrients. Although the appetites of the animals were usually excellent, it was necessary to limit food consumption in an effort to avoid serious bloat. By means of a rumen fistula, made at the time of bloat, gas was collected and found to be principally carbon dioxide, with no detectable amount of methane.

Of the 14 original heifers, 4 died of bloat at the ages of 9 months, 2 years and 6 months, 3 years and 5 months, and 3 years and 8 months; one, of chronic indigestion at 4 years and 2 months; two, of pneumonia complications following posterior paralysis (prior to calving) at 2 years and 3 months; one, of accident at 2 years and 10 months; one, as a result of complications following operative procedure for the formation of a permanent rumen fistula, at 3 years and 4 months; one, at 3 years and 4 months following the removal of a large shoulder tumor. Four are still alive at six years of age.

Reproductive functions have been normal. Four animals have each produced 3 calves; 1 produced 2 calves, and 4 others 1 calf each. Seventeen 293-day lactations have averaged 6,488 pounds of milk testing 3.19. The range in production was from 4,460 to 9.788 pounds of milk, 107 to 357 of butterfat, and 2.16 to 4.58 per cent of fat.

All animals ruminated at irregular intervals.

The efficiency of digestion was found to be similar to that of animals receiving roughage.

With the exception of bloat, due to fermentation with the formation of carbon dioxide, none of the symptoms usually associated with a roughage-free diet was noticed.

The principal limiting factor, when vitamin A had been supplied, appeared to be the susceptibility to bloat when on full feed.

P47. Spectrophotometric Data Bearing on the Character of the Pigments Obtained in Routine Determinations of Carotene in Hays, Silages, and Freshly Cut Plant Materials. EDWARD A. KANE, HERBERT G. WISEMAN, A. H. HARTMAN, AND C. A. CARY, Bureau of Dairy Industry, U. S. D. A.

Evidence from a number of laboratories has shown that the carotene in the grasses and in the alfalfa and corn plants is almost exclusively β-carotene. This agrees with the spectral absorption curves for the carotene obtained in the routine analyses of these substances in this laboratory; but carotene is readily oxidized and the carotinoids are more or less readily altered by acids, leaf xanthophyll being readily attacked even by organic acids. Intermediate pigments are formed in these decompositions. The oxidation products, according to Kuhn and work done in this laboratory, are largely—if not completely—removed from carotene in the Willstätter and Stoll procedure; but Kuhn and co-workers found that the pigments formed by the action of acids on xanthophyll, resemble it in spectral absorption and adsorptive properties, but differ from xanthophyll in being removed from carotene with greater difficulty in the Willstätter and Stoll procedure.

The spectral absorption curves for carotene fractions obtained here in the routine analysis of alfalfa hay indicate the presence of small amounts of colored material other than β-carotene. It is not α-carotene or unremoved xanthophyll. The quantity present is insufficient to materially reduce the vitamin A potency of these extracts when compared biologically with equivalent amounts of β-carotene measured at wave length 436 mμ. Almost identically the same spectral absorption curves are obtained with carotene extracts from corn silage; but we have not tested their potency biologically. When acid (HCl) alcohol is used in extracting fresh green material, a large portion of the carotene is destroyed, and there is difficulty in separating the pigments.

In a sample of alfalfa silage, which was preserved by the addition of acid, we were unable to determine definitely the amount of carotene because of the presence of a pigment resembling that described by Kuhn as formed by the action of acids on xanthophyll.

P48. Rate of Decomposition of Carotene in Hays During Storage at Different Seasons of the Year. HERBERT G. WISEMAN, EDWARD A. KANE, AND C. A. CARY, Bureau of Dairy Industry, U. S. D. A.

Samples of baled alfalfa hay were stored in a fairly dark unheated barn loft, and their carotene content was determined from time to time to get at the rate of loss of vitamin A potency. During December, January, and

February, when the average outside mean daily temperature was 40° F. or less, the average (11 samples) loss of carotene per month was 2.6%; for the colder fall and spring months, when the temperature was 40° to 55° F., this loss was 4.4% per month; whereas during the warmer fall and spring months (average outside mean daily temperature 55° to 70° F.) the loss of carotene (20 samples) was 6.5% per month. During June, July, and August, when the average outside mean daily temperature was 70° F. or higher, the loss of carotene was very much more rapid. Four samples that were stored for the first summer after cutting lost on an average 21.2%; and four other samples during storage for the second summer lost 11.6% of their carotene content per month.

The percentage rate of loss of carotene in timothy hay during storage under the same conditions is practically the same as that in alfalfa hay.

These figures were obtained with hays that appeared to have been normally "cured" and in which no evidence of "fermentation," or of a "ground" or "swetty odor" was observed.

The percentage loss of carotene during the storage of alfalfa hay under the above conditions is very much greater than the percentage loss of natural green color as determined by the Division of Hay, Feed, and Seed, Bureau of Agricultural Economics, United States Department of Agriculture.

P49. Effect of Moisture Content and Density of Stored Roughage on Temperatures Attained During Storage and the Quality of the Product. J. B. SHEPHERD, T. E. WOODWARD, AND R. R. GRAVES, Bureau of Dairy Industry, U. S. D. A.

Two experiments, one with baled long and shredded stover and one with long and chopped alfalfa hay stored loose, furnish some preliminary data on this subject.

THE CORN STOVER EXPERIMENT

In October and November, 1934, four different lots of corn stover were baled with moisture per cents of 45.7, 39.0, 36.4, and 26.7. Each lot included both long and shredded corn stover and bales of different tightness or density. Each lot was stored separately in a small pile surrounded by baled straw.

At the time of baling, shredded stover bales averaged 7.57, 10.17, and 12.70 pounds and long stover bales 6.08, 8.26, and 10.32 pounds dry matter per cubic foot, respectively, for loose, medium-compact, and tight bales. The maximum temperatures attained did not exceed 68° F. in the loose and medium-compact long stover bales containing 26.7 and 36.4 per cent moisture, in the other bales the maximum temperatures attained ranged from 83.0 to 141.0° F. No bales were free from mold. Mold ranged from traces only in some bales to extra heavy in others.

Temperatures and mold were highest in bales with the highest moisture content and lowest in bales with the lowest moisture content, higher in tight bales than in loose bales, and higher in shredded stover bales than in long stover bales. Temperatures averaged higher, but mold growth averaged slightly less in shredded stover bales than in long stover bales containing the same quantity of dry matter per cubic foot; 26.7 per cent moisture was not low enough to prevent heating and mold.

THE ALFALFA HAY EXPERIMENT

In June, 1935, two different lots of first cutting alfalfa were stored loose in separate compartments in both chopped and long condition. Lot 1 consisted of about 6 tons each of long hay and of hay run through a cutter set to cut in ¼ inch lengths. The moisture content of both was 27 per cent. Lot 2 consisted of about 5 tons each of long hay and of hay run through a cutter set to cut in ¾ inch lengths. This lot had 25 per cent moisture. After 100 days of storage, a single reversal feeding trial was conducted with Holstein cows.

At the time of storage the finely chopped hay of Lot 1 occupied 152 cubic feet per ton with 9.60 pounds dry matter per cubic foot; the coarsely chopped hay 218 cubic feet with 6.85 pounds; the long hay of both lots 475 cubic feet with 3.06 and 3.14 pounds. Both long and chopped hays heated in storage; finely chopped hay reached 151° F. in 9 days (some spots 190° F.) and after 3 months was still 100° F.; coarsely chopped hay reached 128° F. in 19 days, subsiding to air temperature in 2 months; Lot 1 and 2 long hays reached 122° F. and 120° F. in 4 and 1 days, respectively, both subsiding to air temperature in 3 weeks.

Stored with 27 and 25 per cent moisture, all hays lost considerable carotene during storage, but long hay retained more carotene than chopped hay of the same lot; long hays lost part and chopped hays all of their green color during storage. Coarsely chopped hay was light brown and finely chopped hay brown to black in color. Dry matter losses during storage were small, but greater for chopped than for long hay. In the feeding experiment, black hay (chopped) was less palatable, but brown hay (chopped) fully as palatable as hay with a more normal color (long); cows produced a little less milk and declined faster in milk production on the black or brown hay (chopped).

A lower per cent of moisture than that used in this experiment is necessary to prevent excessive heating and excessive losses of carotene and color in chopped hay.

P50. The Effect of Certain Factors upon the Color and Pigments of Alfalfa Hay in Storage. T. E. WOODWARD, Bureau of Dairy Industry, U. S. D. A.

Hays lose color and pigments from the time they are mowed until they are stored and also from the time they are stored until they are fed. This

investigation has to do with the losses which take place in laboratory samples of alfalfa hay when stored under different conditions for periods of 6 to 9 months.

Data are presented to show the destructive action of diffused sunlight, warm temperatures, lack of ventilation, and high moisture content upon the green color, chlorophyll, and carotene. The effect of presence or absence of air on the color and carotene content of hays with various percentages of moisture is also discussed. Ways in which the results of this study may be applied practically are suggested.

MANUFACTURING SECTION

M1. Results Obtained when the Several Minnesota Reagents Were Employed for Testing Buttermilk. D. F. BREAZEALE AND E. W. BIRD, Iowa State College.

Three Minnesota reagents have been offered to date—a. The original reagent (termed here, Reagent A) (1); b. One described by Sommer (Reagent B) (2), and c. a third sold by Nafis Division of the Kimball Glass Company (Reagent C) (3). Reagent A had been extensively studied at the Iowa station in connection with buttermilk testing. Dr. B. L. Herrington of the N. Y. (Cornell) station called the attention of the authors to the fact that his results with Reagent C were not in conformity with those reported for Reagent A and stated that he had evidence to the effect that saponification might be responsible for the differences between the methods; a greater saponification occurring with Reagent C than with Reagent A. His methods were not disclosed.

Reagent C contains "Castor oil Potassium Hydroxide Soap solution" (3) so that indirect methods of determining saponification were necessary. A single sample of buttermilk was employed and samples were digested 0, 2, 5, 10, 15, 25, 40, and 60 minutes with each reagent. Triplicate determinations were made at each point. The averages of the triplicate determinations were plotted against time. Each graph rose steeply to a maximum (at approximately the 5 minute heating period) and then dropped off. The slope of the curve after the maxima was greatest with Reagent C, least with Reagent A and was intermediate with Reagent B. These curves were extrapolated to zero time and an average of the values was taken as that which would have been obtained had no saponification occurred. From these data it was calculated that approximately 5 per cent saponification occurs with Reagent A, 8.5 per cent with Reagent B, and 16.75 per cent with Reagent C if the maximum test possible with each test (as shown by the graph) was considered.

It was further shown that this saponification accounts for approximately 27 per cent of the total difference between the test with Reagents A and C. The remaining difference results from differences in manipulation of the tests.

The following figures which are each the averages of 12 replicate determinations of the same buttermilk sample illustrate the relationships among several buttermilk testing methods:

Test Used:	Minnesota A;	Minnesota B;	Minnesota C;	American Assoc.;
Avg. Value:	0.512	0.465	0.198	0.739

Test Used:	Babcock;	Mojonnier*
Avg. Value:	0.249	0.745

* Average of duplicates.

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M2. The Effect of Preservatives on the Results Obtained with Ice Cream Mixes by Several Testing Methods. P. H. Hostetler, C. A. Iverson, and E. W. Bird, Iowa State College.

The testing methods employed were: Crowe test (1), glacial acetic-sulfuric acid test (2), Mojonnier test (3), Overman-Garrett (4), and Minnesota (5).

The results obtained indicate that:

1. Mercuric chloride, potassium dichromate and formalin will prevent spoilage of ice cream mix samples during 8 days when employed in following amounts—a. $HgCl_2$–0.1 gm.; b. $K_2Cr_2O_7$–0.1 gm. and c. 40 per cent formalin–0.1 cc. per 100 gm. mix.

2. When samples were stored at 37° C. reduction of $HgCl_2$ and $K_2Cr_2O_7$ was observed.

3. Formalin seemed to harden the proteins and made it difficult to separate the fat by certain testing methods.

4. Mojonnier tests of preserved samples indicate that this method could be used satisfactorily on samples preserved with $HgCl_2$, $K_2Cr_2O_7$ or formalin.

5. The Crowe test yielded reasonably precise results with samples preserved with $HgCl_2$ but not with samples preserved with $K_2Cr_2O_7$ or formalin.

6. The glacial-acetic-sulfuric acid method did not yield reliable results with any of the preservatives.

7. The Minnesota test showed practically no change between the original and the preserved mixes but yielded a result that was too high.

8. The Garrett-Overman test was not affected by $HgCl_2$ but was changed by $K_2Cr_2O_7$ and formalin. This test, like the Minnesota, was too high.

9. A comparison of the tests on non-preserved mix indicated that —a. the glacial-acetic-sulfuric acid test gave results approximating closely those of the Mojonnier; b. the Crowe tests were slightly higher than the Mojonnier but were sufficiently precise for practical purposes; c. the Minnesota and Overman-Garrett tests if used as prescribed yielded results that were too high for practical purposes, and d. the Minnesota test used with "reader-oil" was still too high, while when used in this fashion the Garrett-Overman checked the Mojonnier value more closely than any other of the centrifugal tests studied.

CONCLUSIONS

1. No comparative study of testing methods involving centrifugal tests for fat in ice cream mix should be conducted with preserved samples.

2. Ice cream mixes containing preservatives should be tested by the Mojonnier method if precise results are desired.

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M3. The Determination of Citric Acid in Milk. HUGH L. TEMPLETON, University of Wisconsin.

The amount of citric acid present in milk or cream may play a very important role in the behavior of manufactured products. Thus it would seem that any method which could be used for the rapid determination of citric acid in milk might serve a very useful purpose in the control of manufacturing processes. Examples of the use and importance of the citric acid in milk are numerous, and one might cite the effect of the addition of certain salts, such as sodium citrate, on the stability of milk for concentration and the relation between the citric acid content of the cream and the flavor and aroma of the butter made from it, since it has been shown that the proportions of these aromatic constituents depend upon the amount of citric acid present.

The methods commonly recommended for the gravimetric determination of citric acid in milk indicate that it is advisable to allow the pentabromacetone precipitate to stand overnight before filtration and then a solubility correction must be made in the calculations. Titration methods have been used by a number of investigators, but most of these have the objection that there are a number of steps in which some of the material may be lost.

This paper presents a study of a number of methods that have been suggested for other materials containing citric acid with modifications designed to meet the conditions existing in milk. Various methods suggested for the determination of citric acid in milk have also been utilized and modified in an effort to reduce the time factor. A volumetric method has been used in which pentabromacetone is formed and extracted with

ether thereby eliminating the correction for solubility. The pentabromacetone decomposes rather readily in ether solution and advantage is taken of this fact to have the bromine that is liberated react with potassium iodide. The liberated iodine is titrated with standard triosulfate solution and the citric acid equivalent is calculated from the results obtained. The ether extract may be evaporated to dryness and the citric acid calculated from the weight of pentabromacetone obtained. This latter method is quite satisfactory if certain precautions are observed and duplicate analyses may be completed within two hours. While the recovery of citric acid is not absolutely quantitative, this method seems to offer a basis for the rapid detection of rather small differences in the citric acid content of milk.

A colorimetric method has also been developed based on the color formation occurring between citric acid acetic anhydride and pyridine. This method has been found to be quite effective in the detection of very minute additions of citric acid to a given sample of milk.

M4. Vitamin C Content of Milk. C. H. WHITNAH AND W. H. RIDDELL, Kansas Agricultural College.

Milk from 40 to 58 cows was tested chemically for vitamin C for three consecutive days in each of the months from October to April. The cows received during this period a ration consisting of alfalfa hay, silage, and a grain mixture. The Ayrshire, Guernsey, Holstein and Jersey breeds were represented by about equal numbers of cows.

The average vitamin C content of milk from all breeds and for all months studied was 25.5 milligrams per liter. Milk produced during the severe weather of January and February with cows in barn contained less vitamin C than milk from either earlier or later months. Daily changes were often large but if large they quickly reversed the direction of change. The only consistent difference found between breeds was that Jerseys were high. This difference was largely due to genetically related cows. The differences between individuals within a breed were much greater than any differences between breeds. The high cow for each month and breed averaged 159 per cent of the low cow. No consistent relation between vitamin C concentration and yield of milk was found. An average increase of 10 per cent in vitamin C concentration was found from the first to second month of lactation. Later changes in stage of lactation were of only minor importance.

For three cows the regular herd ration was replaced by 30 to 40 kilos per day of green rye plus grain. This grass contained about 0.3 mg. per gram of vitamin C. The vitamin C content of the blood of one cow doubled within two hours and remained high between 12 and 24 hours.

Continued grass feeding did not maintain this high blood level nor cause a similar change in the other cows. Within 48 hours after grass was fed the average excretion of vitamin C in urine had increased about five fold. The vitamin C content of the milk had not changed appreciably within 60 hours after grass was first fed.

M5. Vitamin C Content of Dairy Orange Beverages. M. J. MACK, C. R. FELLERS, W. A. MACLINN, AND D. A. BEAN, Massachusetts State College.

A recent development in the dairy business is the successful sale of bottled orange drinks as an adjunct to the distribution of fluid milk. Several articles have appeared in the literature dealing with the handling and sale of these beverages. Many state and city boards of health have passed regulations governing the composition and processing of dairy orange drinks. The vitamin C content is undoubtedly of more significance than any other property and is the principal dietary essential in orange drinks. This study was carried out in order to furnish some much needed information as to the vitamin C content of dairy orange beverages.

The vitamin C content of three dairy orange beverages was obtained by the biological assay method. Twelve samples of ten different dairy orange beverages were examined for ascorbic acid (vitamin C) content by the new chemical procedure of Bessey and King (use of fresh 2, 6-dichlorophenolindophenol indicator) and by the iodine titration method of Reynolds and Stevens. The loss of vitamin C during storage of the beverages was also determined by the two chemical methods just mentioned.

The results showed that there is good agreement between the biological assay method on the one hand and the dye and iodine methods on the other for the determination of vitamin C (ascorbic acid) in orange beverages. Of the two chemical methods used, iodine titration gave more constant and easily reproducible results than the dye method.

Ascorbic acid values of from 0.003 to .093 mg. per gram, corresponding to from 0.2 to 53 units of vitamin C per ounce were found for the different orange beverages examined. For comparison fresh orange juice contained 228–258 units and canned orange juice slightly over 200 units per ounce. The work also showed that reconstituted dairy orange beverages gradually lose their vitamin C content during cold storage at 40° F. This loss is as much as 15 per cent per day.

The study reveals that while dairy orange beverages are fair antiscorbutics, they contain on the average only 10 per cent as much vitamin C as fresh orange juice. Many dairy orange beverages cannot be considered satisfactory substitutes for fresh or canned orange juice as carriers of vitamin C.

M6. Catalytic Destruction of Vitamins by Manganese During the Pasteurization Process. A. D. PRATT, Virginia Agricultural Experiment Station.

In lieu of manganese pasteurizing vessels milk was pasteurized in glass after addition of manganese lactate equivalent to 9 p.p.m. Feeding of this milk to small animals on appropriate basal diets in contrast with similar groups receiving plain pasteurized milk proved an increased destruction of vitamins B_1 and C, but no destruction of vitamin A.

M7. X-ray Diffraction Studies of Cheese Protein During the Ripening of Cheddar Cheese. S. L. TUCKEY, H. A. RUEHE, AND G. L. CLARK, University of Illinois.

An attempt has been made to identify, by means of X-ray analysis, some of the hydrolytic products formed during the ripening of cheddar cheese. The cheese is usually required to age one to two weeks before the diffraction pattern changes from the ordinary pattern with two halos, which is typical of proteins with peptide linkages, to a pattern with sharply defined rings, characteristic of long-chained organic compounds with staggered arrangement.

X-ray diffraction patterns of 20 amino acids were made and the spacings calculated. It was found that the following amino acids gave diffraction interferences of the same order of magnitude as the cheese samples, hence could contribute to the intensity of the diffraction lines of the cheese patterns.

Spacings in Angström Units Calculated from cheese patterns	*Amino Acids*
7.57	Histidine, aspartic acid
4.60	Iso leucine, arginine, methionine and hydroxyproline
4.23	Valine, methionine, histidine, proline, and hydroxyproline
2.92	Iso leucine, proline, hydroxyproline, histidine and serine
2.60	Valine, iso leucine, aspartic acid, proline, hydroxyproline, arginine and norleucine

Crystalline amino acids can be obtained from cheese by extraction with hydrated n-butyl alcohol followed by the evaporation of the alcohol under reduced pressure. The amount of crystalline extract increases with the age

of the cheese. However, traces of it can be obtained when the cheese is but 24 hours old. The hydrated n-butyl alcohol readily extracts the mono-amino, monocarboxylic acids, but upon continued extraction small amounts of diamino and dicarboxylic acids are also extracted. Changes in the liberation of the amino acids in the cheese can thus be followed by comparing x-ray diffraction patterns of the crystalline n-butyl alcohol extract, with standard patterns of the amino acids.

M8. The Relation of the Oxidation-Reduction Potential of Milk to Oxidized Flavor. R. E. Webb and J. L. Hileman, Dairymens League Laboratories.

The development of oxidized flavors in milk by the addition of copper is due to the raising of the oxidation-reduction potential of the milk to a point sufficiently high to bring about a change in some milk constituent.

Summer milk is able to resist the development of oxidized flavors even in the presence of a high oxidation-reduction potential.

The decreased susceptibility of summer milk to oxidized flavor development does not appear to be due to bacteria.

It seems probable that mixed milk from a large number of herds will rarely develop oxidized flavor unless it is contaminated with copper or some other agent that will raise the oxidation-reduction potential.

There is no relationship between oxidized flavors and oxidation-reduction potentials in the milk of individual cows. Oxidized flavors in such samples can develop when the oxidation-reduction potential is very low.

Since the evidence in the literature seems to indicate that oxidized flavor in milk from individual cows is due to oleinase, the data presented here indicates that the mechanism of oxidation catalysis by oleinase is entirely different from the mechanism of the catalysis by copper, since the former does not involve high oxidation-reduction potentials, while the latter does.

Oxidation-reduction potential measurements afford a very delicate means of determining the source of copper contamination in a milk plant.

An improved electrode for the measurement of oxidation-reduction potentials is described.

M9. Some Observations on the Electrokinetic Potential of Milk Fat. E. L. Jack and C. D. Dahle, Pennsylvania State College.

The electrophoretic method was used to study the effect of various agents upon the electrokinetic potential and to determine what substances are responsible for the potential. The results obtained are as follows:

1. The potential is negative in normal milk and is influenced by the addition of electrolytes. Additions of anions in concentrations of multiples of 10^{-3} N decreased the negative potential with increasing valence and tri- and tetra-valent anions reversed the sign. Similar additions of cations increased the negative potential with increasing valence.

2. The isoelectric point of the fat globules is found to be pH 4.3.

3. Heating the milk had no effect on the electrophoretic mobility until pasteurization temperatures are reached and above this the mobility increased with increasing temperatures. There was a progressive destruction of creaming above the pasteurization temperature. However, where the skim milk was heated above the pasteurization point and fresh cream added the creaming was destroyed the same as where the whole milk was heated but the mobility of the fat globules was not affected.

4. The lipoid phosphorus content of the cream per unit of fat decreased with increases in temperature above the pasteurization temperature.

5. There was no deviation from normal mobility due to single stage homogenization with accompanying clumping of the fat globules, or to double stage homogenization which produced no clumping. There was no difference in mobility between individual globules of one micron diameter or clumps of 20 microns diameter.

6. In creams of different fat percentages the mobility increased proportionately with the fat contents from 60% to 81% fat. Up to 60% there was no change in mobility. The lipoid phosphorus content per unit of fat decreased between 60% and 81% fat content.

7. The isoelectric point of butter oil emulsified in distilled water was found to be pH 3.2. When the butter oil was emulsified in 3% casein sol the isoelectric point was pH 4.7. When the emulsifying medium was a milk phospholipid sol the isoelectric point was pH 2.0.

8. A synthetic milk made by emulsifying butter oil in a casein sol and then adding phospholipid, lactose and milk salts gave a pH / mobility curve dissimilar to that for fat globules from normal milk with the isoelectric point of the fat globules at pH 4.6. A similar milk made by emulsifying the butter oil in the phospholipid sol, and then adding the casein, milk salts, and lactose resulted in a pH / mobility curve similar to that for normal milk with an isoelectric point of pH 4.3.

9. When increasing amounts of phospholipid solution were added to butter oil emulsified in distilled water the mobility changed until an amount equivalent to about 16 mgm. lipoid phosphorus per 100 gms. fat had been added. Further additions had no effect on the mobility. The addition of increasing amounts of casein sol to the above system containing 16 mgm. lipoid phosphorus per 100 gms. fat resulted in a change in mobility until the equivalent of 0.4 gm. of casein nitrogen per 100 gms. fat was added. Further additions of casein sol were without effect. These values for lipoid phosphorus and protein nitrogen correspond to those of 60% cream.

The above results seem to the authors to indicate that the electric potential is not responsible for the heat destruction of creaming in milk, nor for the clumping of fat globules in homogenization. The data indicate that the inner layer of the fat globule membrane is phospholipid and that the outer

surface is composed chiefly of protein. The values found by analysis and synthetic studies suggest that 60–65% cream is composed of the fat globule plus its entire absorbed membrane.

M10. A New Type of Quinhydrone Electrode for Directly Determining the Hydrogen-ion Concentration of Cheese and Other Materials. GEORGE P. SANDERS AND EARLE O. WHITTIER, Bureau of Dairy Industry, U. S. D. A.

The use of various modifications of the quinhydrone electrode for following changes in H-ion concentration in cheese was studied. The most satisfactory type of electrode is described below. By direct measurement of pH in the cheese itself rather than in a plug sample, a shorter time is required to carry out the determination, and much of the damage to the cheese due to plugging is obviated.

A 22 or 20-gage gold-plated platinum wire 6 inches long is used as the electrode. It is inserted into a capillary glass tube 4 inches long, 0.09 inches inside diameter, and 0.127 inches outside diameter. The tube or sleeve is flamed to about 0.030 inches in diameter at the tip or lower end and a cup-shaped enlargement 0.35 inches in diameter is blown in the upper end. The same sleeve is used in measurements on either liquids or semi-plastic solids.

The quinhydrone is applied by either or both of two methods, as follows: (1) One end of the electrode is dipped several times in a saturated solution of quinhydrone in acetone and allowed to dry after each dipping; (2) quinhydrone is inserted into the cup-shaped enlargement at the upper end of the sleeve and pushed down into the sleeve by means of the wire electrode.

The determination of pH is carried out as follows: (1) In cheese or other semi-plastic materials, the electrode with quinhydrone is inserted to a depth of 3 inches into the cheese and the sleeve is then withdrawn a distance of 1 inch while the electrode is held in a fixed position so that the quinhydrone-coated wire extends a distance of 1 inch past the sleeve at a position 3 inches within the cheese. The tip of the KCl tube of a calomel half-cell is placed in contact with the surface of the cheese, the usual connections are made, and the voltage is determined with a potentiometer. The use of this apparatus and this procedure makes it possible to insert a sufficient amount of quinhydrone with the electrode, and prevents the quinhydrone from being wiped off during the insertion. The small size of the hole causes only a minimum of damage to the cheese.

The correction for temperature, when the temperature of the cheese is higher than that of the calomel cell, is made by adding 0.00074 volts to the E.M.F. reading. The direct readings in cheese, after adding the temperature correction, were found to be low, the average decrease being – 0.004 volts.

(2) In liquids, the sleeve is thoroughly rinsed with the liquid by suction, the electrode with quinhydrone is inserted into the sleeve, and the sample is

drawn in by holding the tip of the sleeve in the sample and moving the electrode up and down. Capillary action causes the sample to rise about 1 inch in the tube. The voltage is then determined in the usual manner.

A small calomel cell contained in a calcium chloride drying tube has been designed for use with the apparatus; a small L. & N. portable potentiometer has been found satisfactory for field work or factory determinations.

The results of many determinations show that the method as described is accurate and is particularly suitable for factory control operations.

M11. An Improved Motor Driven Curd Tester. LESLIE A. CHAMBERS, University of Pennsylvania.

A new type of motor driven curd tester is described and will be demonstrated. The motor drive is so arranged that the complete test operation is completed in less than one minute, at the end of which time the knife is in position for the next test. Many causes of error in the usual methods of curd measurement have been eliminated. A comparative study reveals that when measurements are made at the rate of 60 per hour the deviation of individual measurements from the mean is reduced by more than one half when the new tester is used. Simplicity and automaticity make possible satisfactory duplication of results obtained by different operators.

M12. Use of a Dynamic Foam Meter for Measuring Foaming Ability of Ice Cream Mixes. J. L. MINKIN AND J. H. ERB, Ohio State University.

A dynamic foam meter such as used for studying thickness of the foam layer and film stability of boiler water was thought to have possibility as an instrument, which would show film stability of milk products and ice cream mixes. The apparatus is called a dynamic foam meter because the observations are made while the formation of bubbles and foam is going on. It is an arrangement for blowing air through a porous disc, made of alundum, into a column of liquid. Constant pressure is maintained. In boiler waters the height of the foam layer was found to be proportional to the stability of the films.

Since milk and ice cream mixes are more complex products than boiler waters, it was necessary to set standards of procedure for running these products in the foam meter. The first experiments were conducted with simple mixtures of various products going into ice cream mixes. The results with these mixtures in the foam meter correlated with their whipping ability in an ice cream freezer. Experiments have also been made with ice cream mixes. It has been found that film stability of a mix, as measured by the foam meter, and the whipping ability of the same mix in the freezer can be correlated in a general way. With more quantitative

studies it is hoped that this instrument may suggest a plan of attack for studying potential whipping ability of ice cream mixes.

M13. Milk Inspection Work in the United States. THOMAS B. HARRISON, University of Tennessee.

A questionnaire was mailed to 212 cities in the United States requesting information by a series of questions. Replies were received from 167 cities with a total population of 29,062,750.

Most of the cities had ordinances and 45 per cent had adopted the standard milk ordinance of the U. S. Public Health Service. The inspectors were appointed chiefly through civil service, by the Health Officer, or by the Mayor. About one-half of the cities required a High School education and one-third a college education to be an inspector.

The methods of analysis employed by the various cities, expressed as percentages of the cities replying, were plate count 97.5, sediment 75.7, lactometer 71.5, methylene blue 38.8, direct microscopic 33.8, and cryoscope 15.7.

M14. A Study of the Abnormal Relationship of Fat to Solids-not-Fat in Milk. H. C. MOORE AND K. S. MORROW, University of New Hampshire.

This is a progress report on work being conducted in an attempt to determine the causes of abnormal relationship of fat to solids-not-fat found in the milk coming from some of our New Hampshire dairy farms.

During the past year the fifteen day composite samples on 40 herds delivering milk to a milk plant in the State were tested for fat and total solids, the latter by the Mojonnier method. This group of producers all represent rather large herds so as to eliminate the individual cow factor as much as possible. The per cent fat for the 24 periods varied from 3.43 to 3.85 and averaged 3.68. The per cent solids-not-fat varied from 8.41 to 8.85 and averaged 8.64, the total variations on fat being 0.42 per cent and on solids-not-fat 0.44 per cent; showing that the solids-not-fat varied more than the fat. When the same comparison is made on several individual herds, the solids-not-fat varied as much as 1.2 per cent during the year while the per cent fat varied only 0.8 per cent.

In the relationship of fat to solids-not-fat in the milk these farms can be divided into three groups, namely—first, those producing milk with normal relationship between fat and solids-not-fat; secondly, those producing milk with a solids-not-fat content abnormally low for the fat content; and thirdly, those producing milk with a solids-not-fat content that is both abnormally high and abnormally low for the fat content. Only a very few farms showed a consistently high relationship of fat to solids-not-fat for the entire period studied.

In addition to the above data, monthly tests have been made on 3-day composite samples from individual cows in the University dairy herd. The average fat test for the same period was 3.87 per cent; solids-not-fat, 8.83 per cent. The relation of fat to solids-not-fat was consistantly above the normal.

A few salients on this investigation to date are:

1. That the solids-not-fat content of the milk from these farms showed greater variations in general than the fat.
2. That the solids-not-fat content is higher in the milk during the time of year when pastures are good.
3. That the solids-not-fat content drops when pastures become short and when the cows are put on barn feeding.
4. That at certain seasons of the year the solids-not-fat content decreases when the fat is increasing.

The continuation of this investigation includes the securing of monthly individual cow samples and a study of the farm and herd management practices.

M15. Quality-Composition Relationships in Goat's Milk. J. C. MARQUARDT, New York Agricultural Experiment Station, Geneva.

It was undertaken to establish the accuracy of determining mean values for the composition of milk based upon samples collected over a wide area at a specified time. Goat's milk samples collected at this station had previously been used to calculate the mean values for goat's milk composition based upon the values collected in one locality over a long period of time. The study has revealed the reliability of the new method of obtaining mean values.

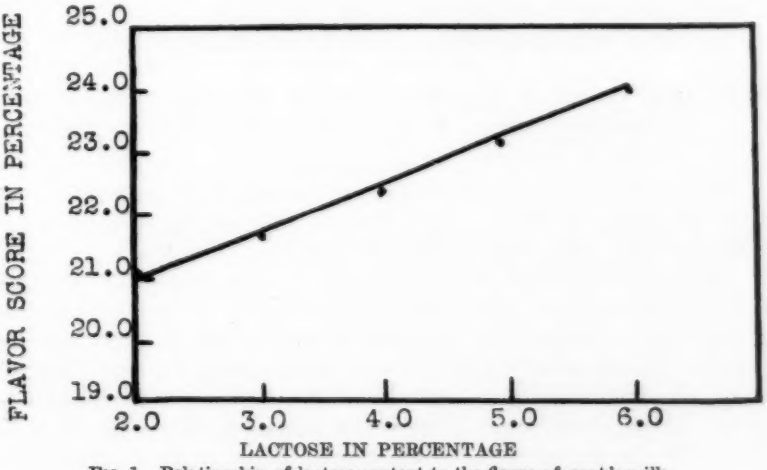

FIG. 1. Relationship of lactose content to the flavor of goat's milk.

This study was started in 1933. Since that time significant data have been collected regarding lactose-salt and quality relationships. High lactose and low salt are associated with quality in goat's milk. Variations in fat, curd tension, and total solids within a liberal range did not affect the quality of the milk. Fat globule size and like matters have been studied.

This project while supplying dairy scientists with organized data has aided goat breeders in improving the quality of their milk in all parts of the country.

The scope of this work is best appreciated by the fact that more than 150 scientists in all parts of the United States assist with the work.

The two figures show the quality relationship to lactose and salt content.

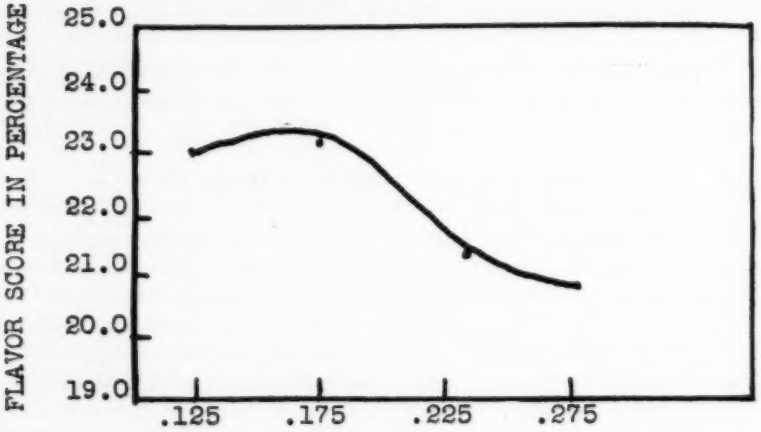

FIG. 2. Relationship of the salt content to the quality of goat's milk.

M16. Observations on the Development of Rancidity in Sweet Milk, Cream and Butter. E. L. FOUTS AND EARL WEAVER, Oklahoma A. and M. College.

For the past several years letters from farmers in the state have indicated that there has been a rather high incidence of the flavor defect in milk, cream and farm butter commonly known as rancidity.

This flavor defect had not been observed in milk from the college herd until in 1932 when an experiment was begun which involved the scoring of milk from individual cows at regular intervals. Rancid flavor has been observed with alarming regularity in milk from as many as three to five cows in an experiment involving twelve to twenty animals over a 140-week period. These observations revealed that rancidity while most likely to occur near the end of the lactation period may occur at most any time

within the milking period. It is the least noticeable during the spring and summer months when the cows are on pasture. In scoring the milks from these cows which scoring included over 5,000 observations, 10.4 per cent of the criticisms indicated some degree of rancidity.

Single milkings from these individual cows were separated and the cream standardized to 35 per cent fat with skim milk from the same lot of milk. The cream was cooled to 45° F. and held at that temperature for 15 hours, after which it was churned in a multiple churn capable of handling six different lots of cream under identical conditions. Milkings from 3 cows of the same breed in a similar stage of lactation were used as checks.

The rancid samples required from 10 per cent to 500 per cent longer to churn than the normal samples. There were no significant differences in the per cent fat in the buttermilk from the rancid cream and the buttermilk from the normal cream. Likewise there were no differences between the tests of the skim milk from the rancid and normal milks. The cream from the rancid samples increased in rancidity while the skim milk was off-flavored but was not rancid. The butter from the rancid cream became rancid with great rapidity and the butter from the normal samples frequently also became rancid. Pasteurization of the milk or cream (145° F. for 30 minutes) soon after milking prevented the off-flavor from developing.

Microscopic observation and measurements revealed very little difference in the size, shape or number of fat globules between the normal and rancid samples of milk. Only in samples of extremely rancid milk could an increased amount of lipolytic activity be detected. Considering the results of these trials it is thought that the decreased size of fat globules near the end of the lactation period is not a very significant factor in the development of rancidity and prolonged churning.

M17. Concerning the Cause of Rancid and Oxidized Flavors of Bovine Origin. J. A. ANDERSON, Bureau of Biological Research, Rutgers University, J. G. HARDENBERGH, AND L. T. WILSON, Walter-Gordon Laboratory Co., Inc., Plainsboro, N. J.

Information acquired over a period of several years suggested that the development of off-flavors in raw milk might be due to the feeding of rations in which certain labile accessory food factors had been greatly diminished by improper curing or by storage. Careful observations during the autumn, winter and spring of 1934–35 on two large farms producing low count milk, one of which had a high and the other a low incidence of individual cows producing off-flavored milks further supported the thought that off-flavors might be caused by dietary deficiencies. Feeding experiments have thus far substantiated this idea.

The more important results obtained thus far may be summarized as follows: Artificially dried alfalfa hay appeared to be richer in the factor, or factors, preventing rancidity in milk than field cured hay of good quality. The temperature at which the alfalfa was dried indicated that the factor sought possessed considerable thermostability. Carrots were very much more potent than the artificially dried alfalfa. Oxidized flavors as well as rancid flavors were eliminated by the addition of carrots to the ration. Milk of good flavor was produced for some days after removal of carrots from the diet, demonstrating storage of the necessary factor in the animal. The time elapsing between enrichment of the diet and elimination of off-flavor was such as to indicate we were dealing with an accessory food factor deficiency. Vitamin A in the form of a cod liver oil concentrate added to the ration of a cow producing very rancid milk resulted in considerable improvement but did not entirely eliminate rancidity in all samples. The results with vitamin A suggested that milk of consistently good flavor could have been produced had the experiment been continued a little longer or the amount of vitamin A increased. The addition of approximately eight pounds of carrots to the daily ration was far more effective than the addition of 500,000 U. S. P. units of vitamin A.

The results of these experiments and all available data concerning feeds strongly suggest a relation between carotene content and ability to produce milk of good flavor. In this connection we wish to call attention to the manner in which seasonal variations in the carotene content of feeds result in variations in carotene and vitamin A content of the milk, and that most off-flavor trouble is experienced when pastures dry or cows are fed winter rations. Furthermore the known chemical and physical characteristics of the substance, or substances, necessary for the production of milk of good flavor are outstanding characteristics of carotene. The information gained from these experiments indicates that carotene alone or with associated compounds is concerned with the prevention of rancid and oxidized flavors in raw milk.

M18. Study of the Causes of Bitter Flavor in Cream. LOUIS J. MANUS AND L. M. THURSTON, West Virginia University.

Certain bacteria, which were isolated from bitter cream, were found capable of causing the production of extremely bitter flavors when cultured in sterile, sweet cream and incubated at relatively low temperatures for a few days. The fact that practically all of the bitter cream shipped to centralizer creameries is received during the winter, when cream storage temperatures on the farms are low, leaves little doubt that some of the bitterness observed is caused by organisms of the types isolated. Two of the cultures of spore forming rods proteolyzed milk rapidly and produced an alkaline reaction. The third culture of spore forming rods curdled the milk with a

strong acid reaction, with possible slow, subsequent proteolytic action. The above cultures yielded negative tests for lipolytic activity. Accordingly, the bitter principal produced by them is believed to be a by-product resulting from protein decomposition.

Two cultures of coccus form, which produced a suggestion of bitterness, were lipolytically active, but produced no proteolysis. It is believed that the suggestion of bitterness they caused in cream was due to the lipase produced by them.

Fifty samples of bitter cream, treated with formalin to prevent bacterial growth, were found to contain lipase in quantities great enough to cause an appreciable increase in acidity. However, the creams did not produce rancidity, showing that either the lipase was inhibited by acid production or it produced other off flavors.

The high bacterial count of the bitter creams studies and the relatively large numbers of the proteolytic and lipolytic types is strong circumstantial evidence that at least part of the bitterness occurring naturally in cream is due to microorganisms. The cream is held at the farms so long previous to shipment as to favor the growth of the undesirable organisms, and because the production of bitter cream occurs almost entirely during the winter season of the year, bacterial action producing either proteolytic or lipolytic fermentation is indicated as the most frequent cause of bitterness. There is little doubt, however, that the secretion of lipase in milk by the cow is the cause for bitterness in some cream.

M19. The Activatability of Milk With Ultra-Violet Light. W. E. KRAUSS, R. M. BETHKE, AND R. G. WASHBURN, Ohio Experiment Station, Wooster.

Information was obtained as to the extent to which certain factors might affect the ultimate vitamin D potency of milk subjected to the same conditions of irradiation with ultra-violet light. Fat percentage, breed, and feed were the variable factors.

After preparing or collecting the samples these were subjected to ultra-violet irradiation from a carbon arc lamp burning industrial C carbons. The distance of the milk film from the source of light, the thickness of the milk film, and the amperage output were the same for the milks to be compared. After irradiation some of the samples were preserved with formalin and stored in a refrigerator until fed; others were dried and stored until fed. Comparative vitamin D potencies were determined according to the usual line test procedure.

Effect of fat percentage. In general, as the fat percentage increased the activatability increased.

Effect of feed. Dry feeding *vs.* pasture feeding—Unirradiated and irradiated pasture milks were more potent than comparable unirradiated and irradiated winter milks.

High protein feeding *vs.* low protein feeding—Milk from cows fed an extremely low protein ration had less initial potency and less potency after irradiation than did milk from cows fed an extremely high protein ration.

A. I. V. silage *vs.* alfalfa hay—Milk from cows fed A. I. V. silage as the sole roughage was less potent before and after irradiation than milk from cows fed alfalfa hay as the only roughage.

It seems that when the fat percentage is approximately constant the chief factor determining the vitamin D potency of milks irradiated under comparable conditions is the original potency of the unirradiated milks.

Effect of Breed. Irradiated and unirradiated Holstein milk standardized to 3.5% fat with Holstein cream and Holstein skimmilk had the same vitamin D potency as irradiated and unirradiated Jersey milk standardized to 3.5% fat with Jersey cream and Jersey skimmilk. When no adjustment for fat percentage was made unirradiated Jersey milk (5.3% fat) had greater vitamin D potency than unirradiated Holstein milk (3.2% fat). After subjecting these milks to the same conditions of irradiation, however, both assumed the same vitamin D potency. This suggests that the solids-not-fat fraction of Holstein milk may contain more activatable material than that of Jersey milk.

M20. The Effect of Feeding Ergosterol to Cows on the Activatability of the Milk. ROBERT F. LIGHT, LOGAN T. WILSON, AND CHARLES N. FREY, Fleischmann Laboratories, New York, and Walker Gordon Laboratories, Plainsboro, New Jersey.

The question has been raised as to whether ergosterol is absorbed through the digestive tract. This was investigated by determining the effect of feeding ergosterol to cows on the amount of vitamin D formed when the milk of the cows is irradiated.

Two groups of cows were fed ergosterol. One group received the ergosterol in the form of dry yeast, and the other group in the form of isolated ergosterol dissolved in oil. Samples of milk from each of these groups and from a control group were exposed to equivalent amounts of ultra-violet irradiation. Butterfats from these irradiated samples were assayed for vitamin D. The samples from both groups of the ergosterol fed cows failed to show any increased potency over the sample from the control group. This indicates that the ergosterol fed to the cows was not transferred to the cows' milk, in amounts detectable by this method.

Following the feeding of the plain ergosterol and dry yeast, the two respective groups of cows were fed irradiated ergosterol in oil and irradiated dry yeast. Butterfat samples of milk from these groups were assayed. The milks in this case were not irradiated. The milk from the irradiated yeast fed group was approximately three times as potent as that from the irradiated ergosterol fed group, although the same number of units of vitamin D was fed to each group of cows.

M21. Treatment of Milk Previous to Separation and the Effect on Viscosity of Market Cream. H. B. HENDERSON AND H. B. ELLENBERGER, University of Vermont.

Trials were carried out to determine the effect of time and temperature factors as related to the proceessing of milk and cream on the viscosity of market cream. Method of cooling, temperature of cooling, and period of holding milk before separation or delivery to the plant were varied to include combinations of primary practical importance. Particular emphasis was placed on the study of temperature and time factors employed in the various plant processing operations. Temperature treatments for improving the viscosity of cream were also studied.

The instrument used in this investigation for measuring the apparent viscosity of cream was the Borden Body Flow Meter with an efflux of 3.5 m.m. in diameter. This instrument was chosen because of its adaptability to this investigation and because the results expressed as relative viscosity were considered to be at least equally as accurate as those obtained with the MacMichael viscometer, which is used quite extensively in viscosity determinations of milk and cream. Unless otherwise stated all determinations were made on cream testing 35 per cent butterfat at 42° F. The cream after separation at 90° F., or after pasteurization, was cooled to 40° F. by immersion in ice water and aged 24 hours before the viscosity tests here reported were run.

Following is a brief resumé of the results obtained:

Raw cream from milk agitated throughout the cooling process had a higher viscosity than did cream from milk agitated only through the first part of the cooling process, or cooled to 60° F. over a tubular cooler and allowed to cool to 40° F. without agitation, the relative viscosities being 25, 19, and 21, and for the pasteurized cream, 7, 6 and 6.

Raw cream from milk agitated during cooling had a higher average viscosity than did cream from milk not agitated during cooling, the relative viscosities being 20 and 13. The same was true with the pasteurized cream, but the difference in viscosity of the two creams was very small, 7 and 6¼.

Raw cream from milk agitated throughout the cooling process had a slightly higher average viscosity than did cream from milk cooled over a tubular cooler at 40° F. or over a tubular cooler to 60° F., the relative viscosities being 27, 24 and 22. This was also true of the pasteurized cream having relative viscosities of 7¼, 7 and 6½.

The pasteurized cream from milk cooled but not aged before separating had a higher average viscosity than did similar cream from milk cooled and aged 15 hours before separating, the relative viscosities being 7 and 6¼.

The average viscosity of pasteurized cream was slightly greater when the cream was aged as cream from cooled but unaged milk before being

pasteurized than when aged as milk before separating, the relative viscosities being 6 and 5¾.

The viscosity of raw cream from milk aged 15 hours before separation was greater than that of cream from milk aged 3 hours or from milk separated immediately after milking and before cooling, the relative viscosities being 22, 17 and 9.

The viscosity of pasteurized cream from milk aged 15 hours before separating was slightly greater than that of pasteurized cream from milk aged 3 hours, but less than that of cream from milk separated immediately after milking and before cooling, the relative viscosities being 7, 6¾ and 8.

The most viscous raw and pasteurized cream was obtained with a separating temperature of 80° F. as compared to others of 70°, 90° and 100° F., the relative viscosities of the raw cream being 57, 42, 32, and 7, and of the pasteurized cream 7½, 7, 7¼ and 6.

These data would indicate that milk agitated during the cooling process, held for a period of 12 to 15 hours and heated to 80° F. for separation should give a more viscous raw cream than milk separated immediately after milking. The variations in results on cream after it was pasteurized were not very significant.

Raw cream testing 40 per cent butterfat cooled without agitation had a higher viscosity than when cooled with agitation or over a tubular cooler, the relative viscosities being 87, 58 and 79.

In the investigation dealing with time and temperature factors as related to the handling of cream, and their effect on its viscosity it was found that there was no very significant differences in viscosity of either raw or pasteurized cream testing 35 per cent butterfat:

When cooled in a water bath of 50° F. as compared to one at 35° F.

When cooled with and without agitation.

When cooled slowly without agitation in a water bath of 50° in the early part of the cooling process and in a bath of 35° in the latter part as compared to cream cooled over a tubular cooler to 48° F. and to 40° F. without agitation in a water bath at 35° F.

The viscosity of pasteurized cream which had been cooled and aged 15 hours before being pasteurized had a slightly, though not significantly, higher viscosity than did cream cooled but not aged or aged three hours before being pasteurized, the relative viscosities being 8¾, 8 and 8.

M22. A Study of the Adaptability of the Vacuum Seal for Milk Bottles.
W. H. Brown, P. H. Tracy, and M. J. Prucha, University of Illinois.

One of the recent developments in the market milk industry is the adaptation of a vacuum cap for regular milk bottles. A metal cap with

a rubberized gasket is used. The usual vacuum of 18–24 inches is secured by expelling the air in the bottle above the liquid level with a jet of steam immediately preceding the placement of the cap. When properly sealed, the contents of the bottle can not leak nor can the milk be removed until the vacuum is broken by puncturing or prying off the lid.

To determine the practicability of the vacuum seal, a study has been made of its relation to creaming, re-creaming, ease of mixing, uniformity of vacuum, bacterial growth, and flavor changes during storage. Information has been secured also as to the consumer's reaction toward this type of cap.

The vacuum did not affect the initial creaming of the milk from the standpoint of either time to form or depth of cream layer. Milk in vacuum capped bottles re-creamed slightly slower than that in regularly capped bottles, and the depth of the layer of cream was reduced to a greater extent by the re-creaming process.

The ease of mixing the cream and milk at the end of 24 and 48 hours was not found to be affected by the vacuum.

Under practical conditions the amount of vacuum obtained has been found to vary considerably from bottle to bottle, and also with the same bottle. The limits of variation between bottles has been found to be from 15 inches to 24 inches, the average vacuum being around 20 inches. The amount of vacuum variation with the same bottle has been as high as 6 inches with the average around 3 inches.

Over a period of a month, there was found to be no measurable increase in pressure in 72 bottles of milk held at 32°–40° F.

The most important factor in determining the amount of vacuum is the fullness of the bottle when capped. A greater vacuum was obtained when not less than 5 cc. or more than 65 cc. of milk was removed. The greatest vacuum was secured when approximately 35 cc. of milk was removed.

From a bacteriological standpoint, the data tend to show that when the milk was held one week or less at 40° F. the increase or decrease in number of organisms was not altered by the vacuum. However, this relationship depends altogether on the types of organisms present in the milk. When the milk was held a considerable length of time (3 or 4 weeks) less surface growth was observed in the vacuum sealed bottles.

Cappy or tallowy flavors usually developed more rapidly in the vacuum capped milk. When the milks were stored for long periods of time, there was usually less undesirable bacterial flavor development in the vacuum capped milks. This was thought to be due to the lessened amount of bacterial growth at the surface of the milk.

Consumer reaction toward the vacuum sealed bottle of milk, in general, was favorable. Out of 322 customers on the University milk route who

returned their questionnaire, 239 stated that they considered the vacuum seal a desirable cap for milk bottles.

M23. Instant Whipping of Cream by Aeration. C. A. GETZ, G. F. SMITH, AND P. H. TRACY, University of Illinois.

The methods used for whipping cream have always employed the principle of agitating the product by some mechanical means whereby gas (usually air) was entrapped by the partially clumped fat and existed in the gaseous state throughout all stages of the process. The method to be described here differs in that the gas which makes up the bubbles is first dissolved in the liquid phase of the product to be aerated. By a release of pressure, the gas is thrown out of solution in the form of small uniform bubbles evenly distributed throughout the cream, resulting in an increased volume of cream and a certain increased rigidity.

The solubility of gas varies directly with the pressure, according to Henry's Law, so that the amount of gas dissolved increases with an increased pressure of the gas in contact with the cream. The rate at which the gas dissolves can be hastened by shaking. When the product is saturated at elevated pressures, it is still in the liquid state. When the pressure is released by allowing cream to flow out of the pressure container through a dispensing valve, the gas that has been forced into solution by the elevated pressure comes out of solution, as soon as the pressure drops, in the form of small uniform size bubbles and a whipped or aerated product results.

From a health standpoint, the gas used should be odorless, tasteless, and non-toxic. Further, it should be soluble to the extent of 100 volumes of the gas at standard conditions in 100 volumes of water. The gas found to be most successful was nitrous oxide (N_2O). However, carbon dioxide (CO_2), diflor-dichlor-methane (CCl_2F_2) and dimethyl oxide (CH_3OCH_3) or mixtures of these gases can be used although they are less satisfactory.

Microscopic studies have shown that the gas bubbles are of uniform size and that the butterfat globules are reduced in size during the whipping process.

Creams of 20 to 40 per cent butterfat have been aerated with equal success as far as increased volume is concerned. Since most consumers prefer whipped cream that is sweetened and flavored, most of the studies have been carried out with a cream containing 6 to 10 per cent sugar and a small amount of vanilla.

The results show that the overrun obtained is directly proportional to the pressure at which the cream is saturated before release, and is independent of the percentage of butterfat content. Overruns of from 200 to 600 per cent have been secured with no indication of fat clumping. Raw

cream, pasteurized cream, homogenized cream, and reconstituted cream were aerated successfully. The overrun is dependent entirely upon the pressure at which the creams are saturated and upon the age of the cream. The best results were secured with unaged cream. An increased viscosity in the cream makes it more difficult to saturate the liquid phase with gas at any given pressure.

For the commercial application of the process, it has been found that unaged cream testing 35 per cent fat (before adding sugar and flavoring) saturated with nitrous oxide at 80–90 pounds partial pressure is satisfactory.

M24. The Influence of Method of Sterilizing Equipment upon the Development of Oxidized Flavor in Milk. A. C. DAHLBERG AND D. C. CARPENTER, New York Agricultural Experiment Station, Geneva.

Exposure of milk at the pasteurization temperature to certain metals increased the iron and copper content of the milk and greatly accelerated the development of oxidized or cappy flavor. The solution of metals was not affected, in these experiments, by the method of sterilization of the equipment but the development of oxidized flavor was most pronounced when chlorine sterilization was employed. Hence, the amount of dissolved copper and iron was not the only factor involved when the milk exposed to these metals became oxidized. When the first hot milk through the equipment was discarded the pasteurized milk showed only a slight tendency to become oxidized especially if the equipment was sterilized with hot water or if chlorine sterilization was followed promptly by a hot water rinse.

Milk as secreted by the cow contained 0.131 parts per million of copper and 0.379 parts per million of iron. After pasteurization of the milk and after the first milk through the equipment was discarded the copper content of pasteurized milk was 0.186 p.p.m. and the iron content was 0.401 p.p.m. These data are relatively low when compared with other data in the literature.

M25. Modified Medium and Incubation Temperatures as They Affect Bacteria Counts of Milk Containing Organisms Arising from Various Sources of Contamination. ALEC BRADFIELD AND H. B. ELLENBERGER, University of Vermont.

It has been demonstrated that media and incubation temperatures, other than those recommended by Standard Methods, are capable of producing higher counts on composite samples of milk.

In addition to further investigation into this matter, this work consisted of an endeavor to ascertain which sources of the contamination of milk sup-

plied the organisms responsible for the increased growth on a modified medium and/or incubation temperature.

Comparisons were made on the Standard Medium and on one composed of Tryptone, glucose, skimmilk and agar, according to the formula of Bowers and Hucker (1935). Incubation temperatures of 37° C. and 32° C. were compared and also combinations of these media and incubation temperatures on the following:

1. Samples of both raw and pasteurized milk including ordinary contamination from all sources.
2. Milk drawn directly from the udder with as little outside contamination as possible.
3. Milk contaminated by poorly washed and sterilized milking machines.
4. Milk contaminated from milk cans containing large numbers of organisms.
5. Milk contaminated by various forms of stable contamination such as dirt from cow's body, manure, bedding, stable dust and feed.
6. Milk held at various cooling temperatures for periods of time up to 60 hours.

Also various types of skimmilk powders were compared as a source of milk for use in media.

An incubation temperature of 32° C. was a greater influence in producing higher colony counts than was the modified medium.

The combination of Tryptone-glucose-milk agar and 32° C. incubation temperature gave the highest counts in the greatest number of instances.

With both raw and pasteurized milk derived from deliveries to commercial milk plants the lower incubation temperature, 32° C., had a greater influence in producing high counts than did the modified medium, but the latter also increased the counts from pasteurized milk.

Milk contaminated from utensils gave the highest counts when plated on the modified medium and incubated at 32° C.

This combination also gave the highest counts when applied to milk that was improperly cooled.

The Standard medium incubated at 37° C. produced as great a number of colonies as any of the other combinations, on milk that contained few or no bacteria other than those derived from the udder.

The results with body contamination gave no significant differences; with feces contamination the Standard medium at 37° C. gave somewhat higher counts; with bedding, dust and feed contaminations the 32° C. incubation temperature gave a more marked advantage in higher counts than did the modified medium which, however, showed some advantage at 32° C. but not at 37° C.

The Tryptone-glucose-milk agar produced larger and more discernible colonies than did the Standard medium, and this factor was of great assistance to accurate counting.

Good quality skimmilk powder is equal in value to raw skimmilk as an ingredient for a medium for milk plating. There was no significant difference between the various types of skimmilk powders used as regards numbers of colonies developing on the plates but difficulty was experienced in incorporating some of them in the media.

These observations indicate that the Tryptone-glucose-milk agar and an incubation temperature of 32° C. would be of more value in milk control work than the Standard media incubated at 37° C. Significantly higher counts were produced on milk which had been exposed to improper methods of cooling and utensil contamination, and somewhat higher counts when the contamination was from stable dust, bedding or feed. When the contamination was from the udder, cow's hair, and feces, there was no significant difference in the counts; therefore, this modified method would aid in detecting poor milk without unduly penalizing clean, high quality milk.

M26. The Present Status of the Proposal to Change the Composition of the Agar and Temperature of Incubation of the Standard Agar Plate Technic of the American Public Health Association. ROBERT S. BREED, New York Agricultural Experiment Station, Geneva.

As the result of the recommendation by Bowers and Hucker (Amer. Jour. Pub. Health, 26, 350–353, 1936) and others that the present standard agar used in official milk analysis be changed in composition to a tryptone-glucose-skimmilk agar, and the recommendation by Yale and Pederson (Amer. Jour. Pub. Health, 26, 344–349, 1936) and others that the standard incubation temperature of 37° C. be lowered to 32° C., numerous comparative studies are being made in public health, milk dealer and private laboratories to determine the advantages and disadvantages that would result from making such a change. In a general way, other laboratories are finding that the improved agar does result in counts that are higher, especially on certain types of samples, than those secured with the present standard agar. Occasionally counts are higher on the present standard agar, but in these cases the difference in count is normally not so large as it is when the conditions are reversed. Larger and more frequent increases in count occur in pasteurized milk than in raw milk and these discrepancies in count become more evident the poorer the quality of the pasteurized milk.

It is becoming increasingly evident that a lowering of the temperature of incubation from 37° C. to 32° C. plays a greater part in producing irregularly increased counts than does a change in composition of the agar. These increases in counts seem to be due to a better growth of streptococci in the case of raw milk and partially also in the case of pasteurized products. In pasteurized products, particularly those that have been stored for some time at a low temperature, such as cream and ice cream mix, this increase in count

seems to be more largely due to the growth of bacteria that find 37° C. too warm than it is to the growth of heat-resistant and facultative thermophilic types. There is no one temperature of incubation that will grow all types of bacteria that should be detected and eliminated if the quality of our milk and cream supplies is to be maintained at the highest level. The present 37° C. temperature is poorly selected as it is too warm for many types of bacteria and too cold for the thermophilic types. It is above the optimum temperature for many types of pathogenic bacteria.

Research workers who feel that they can suggest a medium of a more satisfactory character than the one suggested by Bowers and Hucker are requested to submit evidence supporting their claims as soon as possible to the Committee on Standard Methods for the Examination of Dairy Products of the American Public Health Association. The cooperation of all those who feel that the present technic should be improved is requested in order that the final decision in this matter may be based on the best available knowledge.

M27. *Streptococcus lactis* in Raw and Pasteurized Milks of Very High Quality. E. S. YAWGER, JR., AND J. M. SHERMAN, Cornell University.

It is well known that *Streptococcus lactis* is seldom obtained when isolations are made from quantitative plates prepared from fresh milk of very low bacterial content. It is also well known that when such milks are allowed to spoil at temperatures of 20° C. or above, the lactic acid bacteria frequently do not dominate the other organisms so as to produce a normal souring. These facts have led some to doubt even the presence of *Streptococcus lactis* in milks of very high quality, especially when these milks are pasteurized.

With the use of proper selective methods, we have found that in raw milks having total bacterial counts of less than 10,000 per cc., *Streptococcus lactis* is usually present in numbers ranging from about 10 to 100 per cc. In pasteurized milks of equal quality and containing usually less than 100 living bacteria per cc., *Streptococcus lactis* has usually been found present to the extent of about one per cc. of milk.

M28. The Characteristics of Freshly Isolated Cultures of *Lactobacillus bulgaricus*. J. M. SHERMAN AND H. M. HODGE, Cornell University.

Although *Lactobacillus bulgaricus* is usually considered to be a milk organism, it has been seldom, if ever, isolated directly from fresh milk. Other lactobacilli, especially *L. casei*, are readily obtained from milk, and these organisms have doubtless been confused with *L. bulgaricus* by some workers. Our knowledge of the true *L. bulgaricus* is largely limited to a

few laboratory cultures most, if not all, of which were originally isolated from fermented milks or freshly made Swiss cheese. We have recently isolated more than 200 cultures of the bulgaricus group from fresh milk, and in a few characteristics these freshly isolated cultures depart from the conventional laboratory strains.

As heretofore described, *Lactobacillus bulgaricus* has among other properties the following characteristics: ferments glucose and lactose; does not ferment unheated fructose, maltose, sucrose and the higher carbohydrates, and related substances; produces a large amount of acidity in milk; is facultative with respect to oxygen requirements; and has a maximum temperature of growth around 50° C. The freshly isolated strains differ from the conventional laboratory cultures in the production of only about one per cent lactic acid in milk, in being strongly anaerobic, and in having maximum temperatures of growth at about 60° C. Only a very few of the freshly isolated cultures have maximum growth temperatures around 50° C.

In our collection are some fifteen cultures of a definite variety, or species, which ferment sucrose. The sucrose-fermenting strains produce from 1.25 to 2.0 per cent acid in milk and have somewhat lower maximum temperatures of growth. This variety corresponds to the organisms which have been erroneously classified by Swiss and American workers as the *Thermobacterium* (*Lactobacillus*) *lactis* of Orla-Jensen.

We also have a few cultures which agree perfectly with Orla-Jensen's *Thermobacterium lactis*. This organism ferments fructose, maltose, sucrose and mannitol, in addition to glucose and lactose. However, it very definitely belongs in the "bulgaricus group" as opposed to the "acidophilus group," and may be readily differentiated from the latter by a number of characteristics which cannot be detailed here.

M29. The Heat Resistance of Colon Organisms in Milk. C. N. Stark and Mary Caroline Patterson, Cornell University.

During recent years more importance has been attached to the presence of colon bacteria in pasteurized milk. Much of the sanitary and public health significance which may be attributed to the finding of these bacteria in pasteurized milk depends upon their heat resistance in milk. Many conflicting statements concerning their resistance to heat are present in the literature.

The heat resistance of 505 pure cultures of Escherichia-Aerobacter organisms recently isolated from water, raw and pasteurized milk, and human and bovine feces, have been tested. The milk, inoculated from 24-hour cultures grown in nutrient broth, contained about one hundred million test bacteria per cc. Triplicate tubes of this inoculated milk were immediately tested. All "inconsistencies" were carefully checked. Four hundred eighty-seven, or 96 per cent of the cultures tested failed to survive 140° F. for 30 minutes. Of the remaining 18 cultures tested, 14

were destroyed by 143° F. for 30 minutes; the 4 cultures which resisted 143° F. were destroyed by 145° F. for 30 minutes.

The results of these findings, it is believed, tend to show that the presence of colon bacteria is pasteurized milk is due, in the majority of cases, to recontamination.

M30. The Significance of Bacterial and Chemical Changes Occurring in Mastitis Milk and Their Correlation with Milk Production. L. A. BURKEY, G. P. SANDERS, AND J. F. CONE, Bureau of Dairy Industry, U. S. D. A.

A mastitis study made by weekly examination of fore-milk from first-calf heifers has shown that a more or less definite sequence of changes occurs in the milk coincident with the progress of the disease.

Milk may contain several hundred thousand leucocytes and several hundred *Streptococcus mastitidis* per cc. (plate count) without showing any chemical or physical abnormalities indicating mastitis.

There are frequently cases in which the milk contains large numbers of leucocytes and fibrin clots and may even show abnormalities in rennet curdling properties without the presence of a detectable number of invading organisms. This inflammation, although it may not be considered mastitis, probably provides conditions favorable to the invasion of *Streptococcus mastitidis.*

In a streptococcic infection the milk contains large numbers of *Streptococcus mastitidis,* and millions of leucocytes, and shows other indications of mastitis such as loss of rennet curdling properties, increase in percentage of chlorides and a marked reduction in milk yield. During the peak of the infection the numbers of streptococci and leucocytes in the milk reach a maximum, the chloride content usually is over 0.14 per cent, there is a complete loss in rennet coagulating properties, the pH is markedly increased, there is a large increase in the percentage of non-casein nitrogen, and there is a further drop in milk yield. At the time the infection begins to subside the invading organism disappears, the pH of the milk increases to a maximum, leucocytes are reduced in numbers, there is a prevalence of body cells, and the percentage of chlorides is reduced. As the cow recovers from the infection the milk becomes normal with respect to the percentages of chlorides and non-casein nitrogen, the pH returns to normal, the rennet curdling properties are gradually restored, the number of body cells remains large, and the milk yield usually remains low throughout the remainder of the lactation period.

M31. Frequency of the Escherichia-Aerobacter Species in Commercial Butter. E. H. PARFITT, Purdue University.

During the past year there have been analyzed over 1000 samples of butter coming from 60 different plants. In addition to the routine analysis,

an analysis was made for the presence of the Escherichia-Aerobacter species of organisms in 0.1 ml. of butter using the sodium formate-ricinoleate broth that has been proposed by Stark.

16.91 per cent of the samples in 0.1 ml. quantities produced gas, of this number 10.09 per cent were designated as Escherichia, 5.43 per cent as Aerobacter and 1.38 as being doubtful, when confirmed on Levine's eosin methylene blue agar.

Of the 50 plants which had submitted 12 or more samples, 8 manufactured butter that did not contain organisms that produced gas in Stark's media during the period of analysis.

The highest percentage of samples showing Escherichia-Aerobacter organisms was found during July and August of 1935 when 30.8 per cent of the samples were positive and the lowest in January, 1936, when 3.47 per cent were found to contain Escherichia-Aerobacter types. However there was not found a definite seasonal trend.

No relation was found between the yeast and mold count of the butter and the presence of Escherichia-Aerobacter organisms or between the keeping quality of the butter and the presence or absence of the Escherichia-Aerobacter group in the butter.

M32. A Comparison of Media Used for Determining the Bacterial Content of Ice Cream. F. J. BABEL AND E. H. PARFITT, Purdue University.

The microbiological analysis of 133 samples of commercial ice cream for total bacterial count and Escherichia-Aerobacter content has been made by using different media.

Tryptone-glucose-skimmilk agar as proposed by Bowers and Hucker gave higher total counts than did standard nutrient agar or standard nutrient agar plus one per cent sucrose. Greater differences in count between media were secured in those samples whose bacterial content was less than 50,000 per ml.

A greater percentage of samples showed the presence of the Escherichia-Aerobacter group of microorganisms when 0.1 ml. quantities of ice cream were inoculated into sodium formate—sodium ricinoleate broth and brilliant green bile than when plated on Leifson's sodium desoxycholate agar or violet red bile agar. The difference found between the two broths was negative. Violet red bile agar gave a higher percentage of positive samples and higher counts than did the medium proposed by Leifson.

The data indicates that samples of ice cream having Escherichia-Aerobacter counts of over 500 per ml. were samples with high total counts, and samples low in total count were found to have low or negative Escherichia-Aerobacter counts.

A direct relationship was found between the yeast and mold count as determined on acidulated potato dextrose agar and the total count as determined on standard nutrient agar, indicating the value of the yeast and mold count as an index of sanitation.

M33. The Effect of Certain Penicillia on the Volatile Acidity and the Flavor of Iowa Blue Cheese (Roquefort Type). C. B. LANE, Iowa State College.

Iowa blue cheese, a Roquefort type made from cows' milk, has been manufactured successfully for several years at the Department of Dairy Industry, Iowa State College.

The amounts and type of volatile acids produced in Roquefort type cheeses are of primary importance from the standpoint of the cheese flavor. Investigators have shown that the characteristic peppery flavor of Roquefort cheese is due, in a large part, to the accumulation of certain fatty acids in the cheese during ripening. Presumably, these products result largely from the hydrolysis of some of the cheese fat by enzymes of the Penicillium molds.

It is logical to assume that individual strains of penicillia would show variations with respect to their action on the cheese fat in which case certain strains might be more suitable than others for the normal ripening of the cheese.

Eight different strains of molds, isolated from various samples of Roquefort and blue cheeses, were employed in the experiments. Several lots of cheese were made and the curd of each cheese in the lot was inoculated with one of the mold strains. The total volatile acidity of each cheese was determined at various periods during the ripening, and at the same time barium salts were prepared from the volatile acid distillates. The cheese was also examined organoleptically and scored for flavor.

The total volatile acidities of all of the cheese increased as the ripening progressed. There were, however, large variations in the amounts of volatile acids among the cheese in the same lot, which indicate that the strain of mold used has a definite effect on the amount of volatile acids produced. The barium values obtained on the salts of the volatile acid distillates of the various cheese appeared to decrease after continued ripening. Presumably, there was a greater percentage of fatty acids of higher molecular weight in the older than in the younger cheese. With the different cheese in a lot, only very slight variations were shown in the barium values obtained. Apparently, the strain of mold used has little effect on the types of volatile acids produced.

The strain of mold employed seemed to influence the flavor of the cheese considerably. Certain strains regularly produced cheese having the characteristic peppery flavor of typical Roquefort in a relatively short time, while cheese made with other strains either lacked flavor and aroma or de-

veloped off flavors. The cheese containing comparatively large amounts of volatile acids regularly had much of the sharp, peppery flavor, while the cheese containing small amounts commonly lacked flavor.

One strain of mold appeared to be superior, from the standpoint of cheese ripening, to any of the others employed. This strain is now being used exclusively in the manufacture of Iowa blue cheese.

M34. Sanitary Aspects of Homogenized Milk. M. J. PRUCHA AND P. H. TRACY, University of Illinois.

Homogenization of milk breaks up the fat globules into globules so small that they cannot rise to the surface. It also makes the curd softer, and imparts to the milk a pleasant, rich taste.

Homogenized milk has not had, as a rule, as good keeping quality as the same milk not homogenized. This has led many milk sanitarians to question the wisdom of permitting homogenization of fluid milk.

This study attempted to answer two questions:

1. Why does homogenization affect the keeping quality?
2. Can it be remedied?

The keeping quality of homogenized milk is affected mainly, by the fact that the milk as it passes through the homogenizer picks up additional bacterial contamination. The homogenizer is a complex machine, and hence more difficult to clean and sterilize. This is especially true of the older machines.

The objection to homogenized milk is being corrected in two ways:

1. The improvement in the construction of homogenizers. The improvements have gone so far, that the new machines can be cleaned and sterilized just as easily as coolers, pumps, pipes and other equipment with which pasteurized milk comes in contact. In one dairy where a new machine was used the bacterial count of pasteurized milk was 230 and of the same milk when homogenized was 400.

2. The milk plant operators must learn how to take care of the homogenizer properly. In the dairy referred to above, the machine is taken apart after each use, it is washed in the usual way and treated with plenty of hot water, then air is blown through it to dry it. Just before it is used again, it is assembled, a chlorine solution, 60 ppm, is pumped through it, and then is rinsed with hot water.

There is no need to pass any laws prohibiting homogenization of fluid milk. Sanitarians should insist, however, upon proper cleaning and sterilizing. When so treated, the homogenizer will not be any more objectionable than other equipment such as coolers, pumps, and sanitary piping.

M35. Wrappers for Processed Cheese. HUGH L. TEMPLETON, University of Wisconsin.

In the manufacture of processed cheese the molten cheese mass is filled into foil-lined containers or forms and the foil is closed about the cheese

mass so that a complete and practically air-tight closure results. Tin foil is the most common material used for this purpose, and it is a rather expensive item in the cost of manufacture of this product. For this reason a number of substitutes have been proposed for the tin foil, and this paper presents the results of a study of a number of other foils and films which have been suggested.

Since tin foil is the most important wrapping material for processed cheese it has been the subject of considerable study. One of the defects commonly noted with tin foil is the darkening of the surface of the foil in contact with the cheese. This color change may vary from a dull gray cast on the surface of the foil to black spots and lines. In some instances the surface of the cheese may be discolored. A number of theories have been proposed to explain this discoloration of the foil, and these will be discussed briefly in connection with the presentation of data to show the effect of reaction and emulsifying salts on the color changes of the tin foil.

Aluminum foil has been advocated, but its use has been handicapped by some mechanical difficulties in handling. Pitting of the aluminum foil may occur as a result of interaction with the cheese mass and to eliminate this it has been necessary to cover the foil with a protective coating of shellac or one of the various types of synthetic resins.

Films of a cellulose or rubber-composition base have been tried to some extent, but they have not been satisfactory due to the fact that the cheese acquires a rather unpleasant surface taint.

M36. A Study of Inexpensive Milk Pasteurizing Units for Cheese Factories. WALTER V. PRICE, University of Wisconsin.

Pasteurization of milk for cheese has not been more widely adopted partly because of the cost of equipment. The investment in such machinery commonly exceeds the combined value of all other equipment in the average cheese factory.

Trials have been made to determine the efficiency of two methods of pasteurizing, one a low temperature, the other a high temperature treatment. Data on equipment operation, bacterial reduction, manufacturing losses, and comparative quality of raw and pasteurized milk cheese are presented. The results indicate the possibilities of placing the benefits of pasteurization within the reach of the average cheese factory.

M37. Salting and Cooking Curds in the Manufacture of Several Varieties of Cheese. J. C. MARQUARDT, New York Agricultural Experiment Station, Geneva.

The purpose of this study was to develop fundamental knowledge regarding the salting and cooking of cheese curds. As this work progressed the points of interest to practical cheese makers exceeded those of academic interest. The cheese varieties included in the study were cheddar, granular,

Monterey, brick and Camosum. The first four varieties were made from comparable milks and were used for the comparisons made.

This study has clearly indicated that cheddar and like cheeses should contain 1½ to 1¾ per cent of salt. It has been possible to establish the reliability of various salting methods in making several varieties of cheese. As a result of this study it has been possible to determine the salt losses when adding varying amounts of salt to the curd. It has also been possible to prepare a salting schedule based upon the fat content of the milk. The table is presented herein.

In the cook studies the influence of variations upon flavor and texture were studied. Quality changes were least in the variety order of cheddar, granular, Monterey and brick. It was possible to make cheddar cheese of excellent quality with a moisture content far below that encountered in low moisture content commercial cheeses. Variation in composition influenced the quality of cheddar cheese the least of the varieties compared.

The study indicated that quality assurance was in the following order: cheddar, granular, Monterey and brick when comparable milks were made into several varieties of cheese. Although this has been previously accepted as a fact, organized data to support it have never been supplied.

It has been demonstrated that uniformity and quality are not attainable in making Camosum type cheese from the type of milk generally available where this farm type cheese is made.

The following table gives the amount of salt to add per 1000 pounds of milk varying in test in order to approach a definite percentage of salt in the cheese:

PERCENTAGE OF SALT DESIRED IN CHEESE	LOW	IDEAL		HIGH
	1¼	1½	1¾	2
Fat content of milk	Salt to be added per 1,000 pounds of milk			
3.0	1.3	1.7	2.0	2.5
3.5	1.4	2.0	2.3	2.7
4.0	1.6	2.2	2.6	3.2
4.5	1.8	2.4	2.8	3.5
5.0	1.9	2.7	3.1	3.9
5.5	2.1	2.9	3.4	4.3

M38. The Influence of Salt on the Composition and Quality of Brick Cheese. EVERETT L. BYERS AND WALTER V. PRICE, University of Wisconsin.

Brick cheese was made by the usual curdmaking procedures followed in the industry. Equal amounts of *S. lactis* and *S. thermophilus* cultures

were added each at the rate of 0.05 per cent. The influence of variations in the methods of salting were studied by treating identical curd by different procedures. The methods used were: dry salting, during which the cheese was salted lightly for three days after making; salting in 22 per cent brine for 24, 48, and 72 hours; salting in 26 per cent brine for 48 hours; and salting in 22 per cent brine for 48 hours but beginning the exposure four hours after dipping instead of the usual 20-hour interval after dipping. Each of these treatments was repeated with four different lots of milk.

The rate at which the salt penetrates the cheese depends on a number of such factors as method of salting, concentration of the brine, time of salting, moisture content of the cheese, and the like. The salt content is highest in the outside layer of the cheese during salting and lowest at the center. This difference gradually lessens until at four weeks of age the salt is practically uniformly distributed. There is a more rapid transfer of salt into the center of the cheese in brine salting than in dry salting. There is also a more rapid penetration with the higher concentration of brine.

As the concentration of salt is increased in the cheese by various treatments, the percentage of moisture tends to decrease. The pH of the cheese does not seem to be closely related to changes in salt or moisture during the curing process. Increasing salt concentration affects the quality of the product. The flavor in the ripening cheese develops more slowly and approaches that of Cheddar or Edam cheese as the taste of salt becomes evident. The body of the cheese becomes stiff and brittle as salt concentration is increased beyond the desirable maximum. The texture of the cheese may show a characteristic splitting when the cheese lacks salt. Increasing salt, however, does not seem to produce close texture. The color tends to become white as the salt content is increased beyond the desired maximum. The desirable amount of salt approximates 2.2 per cent of the weight of the cheese. This concentration may be attained by either dry or brine salting but greater uniformity is possible by brine salting. Care must be exercised, however, to regulate the duration of brine salting according to the concentration of the salt bath.

M39. The Utilization of Whey in the Preparation of Some New Food Products. B. H. Webb and G. A. Ramsdell, Research Laboratories, U. S. D. A.

Whey contains approximately half the food solids of milk but although its nutritional value is great it is still almost entirely a waste product or in some cases a stock food. This situation exists largely because whey itself does not have a pleasing taste and because special uses have not been developed for it.

The successful use of whey as a food constituent must depend upon the utilization of its unique properties. The chief distinguishing characteristic

of whey is its lack of casein. This deficiency has been found to be a distinct advantage in the preparation of certain types of food products.

Condensed whey, whey powder, and whey cream have been successfully substituted for milk and cream in canned soups. Less difficulty is experienced with coagulation when a unit weight of whey solids is used than is found after the addition of a similar quantity of milk solids. A soup containing whey solids retains more of its natural color than does a milk soup. Whey solids impart the characteristic milk flavor to soups and greatly increase their nutritive value over products containing no milk solids. The rôle of the various soup constituents was studied and the optimum amount of whey to use was determined.

Normal milk or cream cannot be combined with acid fruits or fruit juices without inducing coagulation of the casein. Various forms of whey solids have been found to be well suited to use with acid foods. When the reaction of a fruit-whey solids mixture was adjusted below pH 4.5 a very low processing temperature could be employed and a cooked flavor avoided. Coagulation of the whey proteins was light and the coagulated particles blended unnoticeably with the fruit pulp. Butterfat was often added, generally in the form of whey cream. In this manner a line of fruit beverages, fruit whips, ice cream mixes for domestic freezing, and fruit flavored whipping creams have been developed. These products were packed and processed in tins and were found to possess excellent keeping quality. Formulae and details of manufacture were worked out.

Ready prepared products of this type should serve to increase the consumption of whey solids as a human food and they should be a great convenience to the housewife.

M40. A Pasteurizing Difficulty Experienced Where Whey Cream is Processed. L. C. THOMSEN, University of Wisconsin.

The cheese industry is now so widespread that difficulties occasionally experienced in the pasteurization of whey cream in Wisconsin may be expected in other states as well. When whey cream is mixed with ordinary farm or factory skimmed cream, curdling during pasteurization may take place at infrequent intervals. Since such curdling does not occur regularly in the same plant, the assumption may be made that this difficulty results only when the mixture has the proper proportion of each, or if the acidity of the two creams is favorable for such curdling, or if the solids-not-fat content is of a definite percentage.

Experimental work was undertaken to determine which of the above factors were responsible, and to what degree. Results indicate that the relative amounts of each cream used, and the acidity of the cream have a definite effect on the amount of curd developed.

The difficulty may be overcome by preheating the whey cream to the pasteurizing temperature before it is added to the regular cream.

M41. A Summary of Results of Experimental Studies of Certain Factors Affecting Churning Losses. H. A. DERBY, D. F. BREAZEALE, AND E. W. BIRD, Iowa State College.

The churnings herein reported were conducted in Cherry Junior churns; it is considered that they are representative of factory conditions. In each group of experiments it was endeavored to hold all conditions constant except the one under consideration. For this reason all churnings were made during the season of "winter fats." The accumulation of these data has extended over a period of five or six years. The fact that excellent correlation exists among data for different years adds weight to their validity.

Primarily fat losses were the chief interest; churning times were recorded. The factors studied were (1) effect of variation of fat content in the cream, (2) the effect of the variation of the protein contents of the cream, (3) the effect of change in acidity of the cream (titratable acidity of cream and buttermilk and pH of buttermilk were determined) with fat levels of 20, 30, and 37.5 per cent fat. In part (3) the range in pH of buttermilk studied was from approximately 4.5 to 7.0.

The results of the study indicated that:

(1) a. Fat losses, calculated as percentage of the fat churned, are a continuous and reducing function of the fat percentage of the cream from 20 per cent cream (loss approximately 2.4 per cent) to approximately 30 to 35 per cent cream (from 1.4 to 1.6 per cent fat loss). In this neighborhood a point of inflection occurs; the loss curve continues to approximately 37.5 per cent fat (from 1.19 to 1.4 per cent), and then rises slightly to 40 per cent cream.

b. The churning times vary with a minimum value for sweet and neutralized cream in the vicinity of 30 to 32.5 per cent cream. With slightly ripened cream the minimum time lies more closely at 25 per cent fat cream.

(2) From protein analyses of the buttermilks of several sweet cream runs the total protein, casein, and heat coagulable proteins in the creams were calculated. The fat losses appear to be more nearly dependent on the casein or total protein contents than on the albumen contents.

(3) a. The results for 20, 30, and 37.5 per cent fat creams yield fat loss (as per cent total fat churned) buttermilk pH curves that are unlike for each of the fat percentages studied. It is considered that this is substantiation of the contention that an actual point of inflection, of the fat-loss, per-cent-fat-in-cream curves, exists.

b. The 20 per cent pH loss curve shows an ill defined minimum at buttermilk pH 6.0–6.25, a marked maximum at pH 4.8–4.9, and a sharp nearly linear drop in loss from this point to pH 4.5.

c. The 30 per cent pH loss curve gradually drops from pH 7.2 to 5.8, is practically constant from pH 5.8 to 5.0, and breaks between pH 4.85 and 5.0 with a downward trend not nearly as steep as with 20 per cent cream until pH 4.5 is reached.

d. The 37.5 per cent pH loss curve bears no relationship to either of the preceding curves except that of a marked change in function at pH 4.8. Minimum loss points occur at pH values 5.45 and 6.2, a poorly defined maximum exists at pH 5.75, and a sharply defined one at pH 5.8 to 5.9.

e. There is no apparently good correlation between churning time and pH or churning time and fat loss with 30 or 37.5 per cent fat creams. The churning time pH curve follows the same general trend as the fat loss pH curve for 20 per cent cream.

CONCLUSIONS

1. Casein seems to play an important part in influencing the trend of churning losses.

2. Under practical conditions the churning time seems not to correlate with either fat loss or pH of cream, for cream with fat percentages of 30 per cent or greater. There is definite correlation among these three factors for 20 per cent cream.

3. The maximum loss point corresponds very well (pH 4.8–4.9) with the points of lowest surface tension for casein and albumen solutions reported in the literature. This would indicate that surface tension and perhaps viscosity effects may be of importance in determining the type of loss curve with change in pH.

4. The data indicate that on the whole a loss of 1.2 per cent of the total fat churned approximates, if it does not reach, the minimum loss possible under practical conditions. This indicates a possible yield in the churning process of 98.8 per cent which is exceptionally good.

5. The pH, fat-loss curves make possible direct comparison between the fat losses under the American (low acid-high fat) churning practice and that practiced in certain sections of Europe (low fat-high acid). They show that insofar as yield is concerned the American system is as good if not slightly better than the European.

M42. A Preliminary Report of the Effect of Certain Neutralizers on the Churning Loss and the Keeping Quality of the Butter. D. F. Breazeale, N. E. Fabricius, and E. W. Bird, Iowa State College.

The neutralizers in this study are grouped in four classes: 1. highly buffered—trisodium phosphate, 2. relatively strong alkalies—sodium hydroxide and sodium carbonate, 3. relatively weak alkalies—sodium bicarbonate and sodium sesquicarbonate, and 4. lime neutralizers—magnesium limes

and calcium limes. To date 16 runs with trisodium phosphate, sodium hydroxide, sodium bicarbonate, and a magnesium lime have been made.

The following data runs have been obtained from these runs: a. pH of original cream, b. pH of cream after neutralizing (sample held without starter in the same cooler in which the cream to which starter was added was held; pH values were run at churning time), c. pH of cream (to which starter had been added) at churning time, d. pH of butter serum at beginning of storage period, e. pH of butter serum at end of storage period, f. acidity of fat of butter, g. acidities of the creams at the times that pH values were determined, h. per cent salt in butter serum, i. scores of butter at beginning and end of storage period, j. Mojonnier test of buttermilk and k. Babcock test of cream. The butter samples were stored 6 weeks at 28 degrees F. The data indicate that:

1. The churning losses calculated as the percentage of total fat in the cream follow the usual fat in cream-buttermilk loss trends, and that such differences in pH as occurred among the cream samples had no effect on the losses. There seemed to be no effect on the losses, generally speaking, of different neutralizers.

2. There seemed to be little correlation between quality of butter as indicated by judges' scores and a. pH of original cream, b. pH of cream after neutralization, c. pH of cream at time of churning, d. pH of butter serum and titratable acidity of butter fat from the butters as long as the pH at the time of churning lay within the ranges 5.9 to 7.5 for sodium hydroxide; 6.3 and 7.25 for trisodium phosphate; 6.1 and 6.9 for sodium sesquicarbonate and 5.8 and 6.5 for magnesium lime. These were the ranges covered. The following summary table shows the relationship between the average cream pH values and the average scores:

TABLE 1

NEUTRALIZER	pH AFTER NEUTRALIZATION. NO STARTER	pH AT CHURN. TIME. 7 PER CENT STARTER	SCORE OF BUTTER IN STORAGE	SCORE OF BUTTER OUT OF STORAGE	DROP IN SCORE
Sodium hydroxide	6.92	6.48	91.06	90.56	0.50
Trisodium phosphate	6.94	6.59	90.48	90.34	0.14
Sesquicarbonate	6.73	6.42	90.57	90.41	0.16
Magnesium lime	6.39	6.08	90.81	90.43	0.38

3. When plotted the pH value of the butter serum showed a definite relationship to the pH of the cream for each neutralizer although the slopes of the curves and their placement on the abscissa (pH of cream) varied somewhat. When the butters came from storage the pH values of magnesia lime neutralized samples seemed to have become somewhat higher in some samples.

4. The titratable acidity of the butter fat appears to be a function of the original cream. When the acidities are plotted against pH of sour cream they fall in groups at that pH value and the higher the acidity in any one group (*i.e.*, one cream sample) the lower the pH value for that sample and vice versa. If the average acid value for the group is plotted against the pH value of the sour cream a correlation appears to exist between these values.

5. When the pH values of the creams after neutralization or at the churning time are plotted against titratable acidities of their respective creams a different graph is obtained for each neutralizer. The general trend of these curves can be indicated by table 2.

TABLE 2

TITRATABLE ACIDITY OF CREAM	pH VALUE OF CREAM			
	Sodium hydroxide	Sodium sesquicarbonate	Trisodium phosphate	Magnesium lime
0.30	5.50	5.75	6.10	5.90
0.20	6.25	6.35	6.75	6.20
0.10	7.10	7.10	7.40	6.70

These values seem logical since trisodium phosphate is a strong buffer, magnesium lime reacts with casein in such a way as to remove a part of it from the system, and both sodium hydroxide and sesquicarbonate are poorly buffered (for CO_2 is lost during pasteurization).

They likewise explain why, in general, less difficulty may be encountered with the magnesium limes than with the soda neutralizers. Section 3 above, however, indicates that, either because of hydrolysis of lime caseinates or for some other reason, the butter from lime neutralized creams may increase slightly in alkalinity during storage.

6. These data are too few (16 runs) to warrant drawing sweeping conclusions and should be considered as indications only. They do point out the need for reliable data (which it is hoped this study will yield) concerning optimum pH values that should be striven for in neutralizing cream with different neutralizers.

M43. Some Factors Influencing the Spreadability of Butter. S. T. COULTER AND W. B. COMBS, University of Minnesota.

A study was made of the effect of variations in the manufacturing process on the spreadability of butter. The avoidance of excessive cooling of the cream and of cooling cream to a low temperature over a surface cooler, the use of a relatively high churning temperature, and the proper use of low temperature wash water were found to improve the spreadability of butter. The most desirable butter body may not be associated with maximum spreadability.

M44. A Proposed Score Card for Judging Churning Cream. L. H. Burgwald and J. H. Erb, Ohio State University.

With the advent of cream improvement campaigns there has been a demand for a suitable churning cream score card. A scoring plan is suggested for general use, which bases the score of the cream on the score of the butter made from any given lot of cream. This score card has been used in a statewide vocational high school cream judging contest. The allocation of points is as follows:

	Perfect	*Normal Score*
Flavor and Aroma	60	46–54
Sediment	10	5–10
Acidity	15	0–15
Per cent Fat	10	0–10
Container	5	3–5

In the paper the numerical cuts for various flavor defects are discussed. The standards for sediment, acidity, and butterfat are given. It is proposed that the association formulate a suitable universal score card for churning cream, which may serve as a basis for scoring.

M45. A Comparison of Pressure and Centrifugal Homogenization of Ice Cream Mixes. J. C. Hening, New York State Agricultural Experiment Station, Geneva.

In these studies ice cream mixes homogenized by pressure and homogenized with a centrifugal colloidal mill were compared for viscosity, size of fat globules and fat globule clumps. The texture and body of the ice creams prepared from these mixes were also compared.

The two stage homogenization of ice cream mixes at low pressures produced mixes and ice creams which were similar in the above mentioned properties to mixes processed with the centrifugal colloidal mill, except that the colloidal mill ice cream mixes contained no fat globule clumps.

When ice cream mixes prepared without gelatin were homogenized with pressures on the first stage ranging from 400 to 1000 pounds, decreasing at 500 pound intervals with a constant pressure of 500 pounds on the second stage, they showed a gradual decrease in viscosity from 4000 pounds to zero pressure. The colloidal mill mixes were a little less viscous than the unhomogenized mixes. The fat globules showed a slight increase in size from 4000 to 2500 pounds pressure with greater increases at each succeeding reduction in pressure.

The texture and quality of the ice creams were good at the higher pressures with a trace of coarseness at the 2500 pounds pressure. The ice creams prepared from mixes processed at the lower pressures were coarse and the

centrifugal colloidal mill ice cream was a trifle coarser than the unhomogenized ice cream.

When ice cream mixes prepared without gelatin were homogenized with a constant pressure of 2500 pounds on the first stage and the pressure on the second stage was decreased from 2000 to 500 pounds at 500 pound intervals, the 2500 first stage and 2000 pound second stage pressure mixes were more viscous, contained larger fat globule clumps and whipped a little less readily than the mixes with a greater difference in pressure between the first and second stage. The body and texture of the ice creams prepared from these mixes were similar.

Other tests using a pressure of 3500 pounds on the first stage and pressures ranging from 3000 to 500 pounds at 500 pound intervals on the second stage gave the same general results.

The texture and quality of the ice creams from the mixes processed by these two methods were approximately the same only when stabilized with 0.5 per cent of a medium grade gelatin and when the pressure homogenization on the first stage was below 1200 pounds.

M46. The Use of Sodium Alginate as a Stabilizer in Ice Cream. P. H. Tracy, G. L. Gibson, and S. L. Tuckey, University of Illinois.

Sodium alginate, a derivative of a sea weed, kelp, gathered off the Pacific Coast of the United States has been compared with 225, 215, and 175 Bloom gelatins from the standpoint of their stabilizing action in ice cream. The action of sodium alginate in the mix was found to be more rapid than that of gelatin, so that aging is not so important a factor when using sodium alginate as when using gelatin. Ice creams stabilized with sodium alginate melted more rapidly when exposed to room temperature than did those containing gelatin.

When equal amounts of sodium alginate and 225 Bloom gelatin were used in the mix, ice creams of approximately the same body scores resulted. When the two stabilizers were so used there was little difference in the time required to reach 100 per cent overrun.

Mixes containing the sodium alginate, when examined with the K and E color analyzer, showed slightly more color than the gelatin mixes. When the sodium alginate was dispersed in the mix after homogenizing, a slight amount of visible sediments was detectable when a small portion of the mix was passed through a sediment disk.

Sodium alginate caused the mix to have a slightly lower titratable acidity and increased the pH reading.

M47. Recent Studies on the Use of Dextrose in Ice Cream. W. J. Corbett and P. H. Tracy, University of Illinois.

A study is in progress relative to the merits of replacing a part of the sucrose in ice cream with dextrose. Since dextrose depresses the freezing

point to a greater extent than does sucrose, it is desirable to replace only a portion of the sucrose with dextrose. When used in conjunction with sucrose, the hydrous dextrose has a sweetening value of approximately 83 while anhydrous dextrose has a sweetening value of practically 100, as shown by consumer tests.

Dextrose produces practically no effect upon color, does not have any effect on protein stability as measured by the alcohol test, does not effect the curd tension as determined by Hill curd test, and generally decreases the pH slightly depending on the time and temperature of pasteurizing. When the sugars are added before processing, dextrose mixes generally have a lesser viscosity than do sucrose mixes. However, in solution of gelatin and sugar in water this relationship does not hold true suggesting that dextrose possibly affects the degree of protein hydration in the mix.

The average overrun of mixes frozen on 10, 12 and 40-quart batch freezers shows that mixes made from part dextrose[1] and sucrose whip to 100 per cent overrun in the same length of time as do all sucrose mixes. It was found further that it does not take any longer to remove the heat from dextrose-sucrose mixes than from all sucrose mixes.

Dextrose ice creams should be dipped at lower temperatures to avoid excessive dipping losses. Comparative hardness tests show little difference in the resistance to penetration at temperatures below 0° F., but above this temperature dextrose ice creams are less resistant than the all sucrose ice creams. Dextrose ice creams melt down slightly more rapidly than do those containing all sucrose (percentage loss at end of 2½ hours from 2 to 5 per cent greater).

Dextrose mixes when frozen in the Vogt freezer have a lower drawing temperature than the all sucrose mixes. It was noticed that the bodies of the dextrose ice creams frozen on the Vogt freezer are heavier than those of the all sucrose products. This difference can be minimized by reducing the gelatin content of the dextrose mixes.

From 1322 consumer tests conducted during this study, it was shown definitely that dextrose sugar has no detrimental effect upon the flavor of ice cream. From the standpoint of body preference, the dextrose ice creams met with practically the same favor as did the all sucrose products. The slightly quicker melting and colder reaction on the tongue of the dextrose ice cream makes the use of dextrose in high solids ice creams, particularly during the summer months, of special value.

[1] Dextrose mixes refer to mixes in which one-fourth of the cane sugar has been replaced with dextrose.

EXTENSION SECTION

E1. Securing Qualified Testers. C. R. GEARHART, Pennsylvania State College.

Qualified testers should be:

1. Men well trained for their work as the job requires considerable knowledge and technical skill.

2. Men who will win the respect and confidence of the dairymen; congenial, honest and thoroughly sold on their work.

3. Young men with dairy farm experience.

Some difficulties experienced in locating men with the above qualifications, are:

1. Too often applicants for testers' jobs are interested only in the salary, or they take a job as a stop-gap until something more desirable appears.

2. Sometimes we find otherwise desirable men who hold an aversion to entering a new, strange home every day or two.

3. We often have difficulty in demonstrating to candidates for testers' jobs that the job presents unlimited possibilities for the study of dairy methods and feeding practices.

4. Then too, there is the difficulty in proving to testers that their job can, by its intelligent use, be made a stepping stone to other positions such as that of herd managers, county agents and salesmen with commercial companies who are affiliated with the dairy industry.

The problem of securing qualified testers harasses every D.H.I.A. Supervisor and in an effort to solve them we have summarized from a questionnaire submitted to such supervisors.

E2. Dairy Herd Improvement Association Supervisor's Conferences. M. J. REGAN, University of Missouri.

Dissemination of new information in the field of dairy husbandry, more complete records, a continued increase in the efficient use of dairy herd improvement association records, and the service rendered to its members as an organization, are major factors in the progress of dairy herd improvement association work in the United States. In the early stages of the development of dairy herd improvement association work, these factors could be dealt with on a personal service basis. Continued growth of organization, however, has made it necessary to handle these factors through the development of leadership and adopting the plan of group teaching. It has been found that approved practices can best be introduced and fostered through the supervisor of the local dairy herd improvement association. These supervisors may best be contacted in conferences where the details of proposed projects may be thoroughly explained.

The growth of dairy herd improvement associations, an increase in the service to their members, and new developments in agriculture make it apparent that a study should be made of some method of systematically and efficiently contacting all members. In an attempt to inaugurate a study of this kind, the following questionnaire was sent to the dairy extension specialists throughout the United States:

1. Do you hold testers' conferences? .....
2. If conferences are not held, what is the method of contacting testers? .....
3. If you hold conferences, do you make other personal contact with testers? If so, how often ..... and by whom .....
4. Give the number of statewide conferences held yearly .....
   Give the number of district conferences held yearly .....
   What is the length of each conference? .....
5. Who handles the program? Does the extension dairyman ..... a tester ....., or a county extension agent ..... act as chairman? (Check the ones who act as chairmen.)
6. Do members of the resident staff ....., county extension agents ....., testers ....., extension dairymen ..... appear on the program at the conference? (Check the ones who assist you on the program.)
7. Do you hold testers' conferences every year? .....
8. Who pays the testers' expenses while attending .....
9. Are your conferences considered a school for training new testers? .....
   Is an additional training school held for new testers .....

Forty-seven questionnaires were sent out, and forty-one were returned. A summary of the forty-one questionnaires returned shows 19 states reporting as holding testers' conferences; 18 states reporting as never having held a conference; two states reporting as having discontinued this practice; one state reporting holding conferences "not regularly" and one state reporting as "planning to hold conferences this year for the first time."

The states not holding conferences, indicated that they contacted their testers through personal visits and correspondence. Most of the states not holding conferences contacted their testers with definite regularity. These contacts were made by the extension dairyman or the state supervisor.

Of the 19 states holding testers' conferences, 18 reported that the dairy extension man contacted each tester two or more times during the year in addition to the conference. Thirteen states hold one statewide conference each year; two states hold two statewide conferences each year, and most of

the states hold statewide conferences in addition to district conferences. District conferences in practically all cases are one-day conferences. The length of the statewide conferences in general, is from two to three days.

In three states the tester acts as chairman, and in thirteen states the extension dairyman is in charge of the conference. Members of the resident staff, extension dairymen, representatives from the U. S. D. A., testers and county extension agents appear on the program at the various conferences. Only three states reported using the conference as a school for testers. Eleven states reported that additional training schools were held for new testers. A sample conference program is as follows:

CONFERENCE PROGRAM

Spring 1936

First Day

10: 00–12: 00—Individual conferences. This time is for getting acquainted and for discussing individual problems. New testers are especially urged to take advantage of this time.

Afternoon

1: 00– 1: 15—This Winter's Job Well Done.
1. Status of testing.

1: 15– 2: 15—Changes in the testers' manual.
1. New herd books.
2. Automatic retest reports.

2: 15– 2: 45—National Soil Conservation Program and Its Probable Effect on Dairying.

2: 45– 3: 15—Pasture and Hay Crops in New Program for Agriculture.
1. Summer herd management.
2. Hay curing and hay storage.

3: 30– 4: 00—Dairy Calf Club Work.

4: 00– 4: 30—Testers' Narratives on the Air.

4: 30– 5: 00—General Discussion.
1. Keeping equipment in good shape.
2. Standard Associations.
3. Testers' Records and Reports Contest.
4. Mailing Lists, Changes—additions, etc.

Morning

8: 00– 8: 45—Our Better Sire Program.
1. Proving sires.
2. Bull record book project and better sire contest.
3. Sire index contest.
4. Sire exchange.

8: 45– 9: 15—Mutual Problems in Herd Testing.
1. How costs are handled.
2. Mistakes on reports.
3. Status of H.I.R. Testing.

9: 15–10: 00—Herd Analysis.
1. Germ Plasma Survey data.
2. Permanent herd books.
3. Future plans.

10: 15–11: 00—Planning Summer Programs.
1. Tours and picnics.
2. Field days of breed associations.
3. Dairy Cattle Congress Activities.
4. Exhibits.

11: 00–12: 00—General Discussion.
1. Scheduling dates.
2. Signing expense accounts.
3. Better Sire Committees.

E3. Combining Farm Accounts with D.H.I.A. Records. E. A. GAUNTT, New Jersey.

Although considerable thought has already been given to the possibility of combining farm accounts with D.H.I.A. work it is evident that the idea is still in the embryonic stage so far as most of the states, including New Jersey, are concerned.

Some few states have tried the combination and find that it works. Probably the pioneers in this field are Michigan and Wisconsin.

A. C. Baltzer, of Michigan, states that they tried the idea in 1932 and found the work so valuable that they have continued it with a small number of herds in each association. He states that by selecting five, or at the most ten, farmers in an association no unduly heavy burden is placed on the tester. The testers are paid $3 extra for each completed record. Apparently Illinois thinks more of the record, as that state pays $5 for each record and C. S. Rhode writes that the plan works.

Glen Vergeront, of Wisconsin, writes—"Of course you realize that this is just one more task for the cowtester who now has his hands full." Yet they too feel that the records are too valuable to give up and Mr. Vergeront stated that farmers have written in telling of their appreciation of such help.

Ramer Leighton, of Minnesota, states that they are trying it in two associations this year and may try it in four next year, but it is too early yet to predict the feasibility of the plan.

G. E. Gordon advises that the plan is not practical in California because most of their testers are handling 1,000 cows or more each month.

Floyd Johnston, of Iowa, writes that they had such a plan in mind about a year and a half ago but the Farm Management Department finally decided to organize separate farm business associations set up similar to a D.H.I.A.

Only those states having a considerable number of associations were questioned, hence other states may be doing this type of work. Nebraska, Ohio, Vermont, Connecticut and New Jersey are also considering the plan but have not put it into operation as yet.

Apparently there are two different ideas as to the type of this Farm Account record. Some want cost accounts, *i.e.*, getting complete costs of producing milk, while others seem to be more interested in a simple record of cash income and outgo covering the entire farm operation.

In New Jersey the dairy and agricultural economics departments agree that they want the cash transactions on the entire farm set up as they feel that enough figures are available to work out total costs on milk production if the cash costs are complete. Furthermore, they have seen several instances of farmers having excellent herds of dairy cattle according to D.H.I.A. records and yet because of poor farm management practices they have gone bankrupt or lost their farms. In any county one such event creates a terrific handicap for D.H.I.A. work and in fact may jeopardize the entire extension set-up.

Since D.H.I.A. cooperators are considered demonstrators of better dairy practices the members of the New Jersey dairy department firmly believe that for our own protection, and particularly for the benefit of the farmer, we must try to work out some simple system for combining these two very important types of records.

E4. The County Agricultural Agent's Responsibility in Connection with a Testing Program. G. E. GORDON, University of California.

I. County agent should actively supervise the testing program in his county.

II. County agent should provide the contact between the state office and the tester and members of the association.

III. County agent should direct tester activities.

IV. County agent should supervise summarization of all reports and all publicity.

V. County agent should contact individual members.

VI. County agent should plan programs of activities in cooperation with the members of the association and the tester.

VII. County agent should supervise plans for maintaining membership in associations.

E5. Handling Herd Improvement and Advanced Registry Testing in Connection with Cow Testing Associations. FLOYD JOHNSTON, Iowa State College.

Herd Improvement and Advanced Registry testing handled by the same staffs who supervise cow testing associations seems to be a distinct service to dairymen. Such a plan makes it easy for the breeders to test at a minimum cost. More herds and cows are tested in the states where the work is under the same supervision. Herd Improvement Registry testing as fos-

tered by the national dairy breed associations seems to strengthen cow testing association work and there seems to be no complications arise from the supervision of the Advanced Registry testing.

A study was made of questionnaires received from 40 states. The official testing (which includes advanced registry and herd improvement) in 17 of these states is supervised by the same staff as supervises the cow testing association work. Sixty-five and seven-tenths per cent of the herds on herd improvement registry test and 47.1 per cent of the cows on advanced registry test in the 40 states are in those 17 states. Fifty-five per cent of the cow testing associations in the United States with 59 per cent of the herds on test are in the 17 states.

There seems to be a definite trend for the supervision of official testing to be placed under the same staff in the Extension Services that supervise cow testing association work. This trend has been manifest most since the national dairy breed associations adopted the "herd test." Besides the 17 state where the supervision is already in the Extension Services 9 other states stated they had discussed making a change. The average length of time the Extension Services in the 17 states have had supervision of the official testing is 5.6 years with a range of from 6 months to 15 years. Six states have made the change since January 1, 1933, and 3 states have made the change within the last year.

The supervision of official testing in the 17 states requires on the average 21.1 per cent of the time of an Extension Dairyman and 36.8 per cent of the time of a clerk. Nine of the states reported an increase in the number of cow testing association members because of the supervision being under the same department and they felt the time justified. Two states reported a decrease in association members and 6 reported no effect one way or the other.

Twenty-six of the 40 states permit association testers to conduct advanced registry tests and all 40 states permit association testers to conduct herd improvement registry tests. Ten of the 17 states pay association testers extra for conducting herd improvement registry tests along with cow testing association tests. Only seven of the 17 states reported difficulty with testers becoming familiar with the breed association regulations. A remarkably few—only two—states reported any difficulty in the attitude of the breeders toward the Extension Services due to collections.

The range in the charges for a one-day test for advanced registry was from $2.25 plus travel expense to a flat rate of $10.00 with an average of $5.43. The charges for herd testing ranged from $2.25 to $9.00 for a one-day test with an average of $4.59. Of the 40 states 32 reported their testing departments were self-supporting if they excluded salary of superintendents; 3 states reported a loss and 5 states a profit.

A detailed summary of the study will be distributed in mimeographed form at the Extension Section meeting.

E6. Conducting a Bull Association Program. S. J. BROWNELL, Cornell University.

I PROMOTION

Bull associations are promoted.

A. General Dairy Meeting.
B. Breeding Schools.
C. Sire campaigns.
   a. Publicity.
   b. Lessons.
   c. Better bull bulletins and letters.

II REQUIREMENTS FOR ORGANIZATIONS

Before a bull association is organized there are five qualifications on which all prospective members must be in accord.

A. Disease.
B. Quality and price of bulls.
C. Record keeping.
D. Housing and management of bulls.
E. Compatibility.

III OPERATION

A. To be recognized as a bull association there must be:
   a. An adopted constitution and by-laws.
   b. Not less than three blocks.
   c. Three or more bulls transferred on the herd books of the National Breed Association to the Bull Association.
   d. Not less than one meeting held each year.
B. Bulls are rotated every two to three years in the numerical order of the blocks, to avoid inbreeding. A young bull is added every two to three years. This bull is kept as a spare to be used in emergencies and rotated every three months for sampling. This starts new bulls with a minimum of breeding risk to each member.
C. Bulls are paid for by assessments levied equally on each block and the cost within the block is distributed among the members of that block in proportion to the number of females in each herd that is of breeding age.
D. A block consists of one or more dairymen who will support an association bull.

IV SUPERVISION

The Dairy Husbandry extension specialist of each state is responsible for the success of each association within his state.

A. He promotes the association on a sound basis.
B. He assists with the formation of a good organization.
C. He establishes a system of records for the bull keepers and secretary-treasurers.
D. He supervises a program of meetings, education and work.
E. He arranges for and attends each annual meeting where he:

a. Visits every member.
   1. Inventories every herd for progress.
   2. Checks type and quality of the offspring of the association bulls.
   3. Discusses the problems and successes with each member.
b. Visits the bull keepers.
   1. Checks the breeding record of the bull for fertility and sterility.
   2. Checks the service fees collected.
   3. Prepares the bull keepers annual report.
c. Visits the secretary-treasurer.
   1. Audits the books.
   2. Checks the secretary's book.
d. Visits the President.
   1. Provides an order of business.
   2. Discusses the problems that will come up before the meeting.

F. At the annual meeting the specialist guides the meeting according to the problems located during the day and addresses the meeting on the successes gained and points out the future program.

G. Following the meeting he prepares the records of the organization.

E7. The Future Dairy Herd Improvement Association Sire Program.

E. E. HEIZER, Ohio State University, AND J. F. KENDRICK, Bureau of Dairy Industry, U. S. D. A.

The suggested Future Dairy Herd Improvement Association Sire Program provides for the following organization:

A. Phases centralized in the Division of Dairy Herd Improvement Investigations, Bureau of Dairy Industry.
   1. Positive identification of all animals in the Dairy Herd Improvement Association herds. A uniform identification system is presented.
   2. Organization of a permanent record system for keeping lifetime lactation records of all cows tested in Dairy Herd Improvement Associations, as well as dam and daughter records, for use in the National Dairy Herd Improvement Association Sire Program.
   3. Periodical publication of a proved sire list.

B. Phases of the program decentralized in the Extension Divisions of the various states.
   1. Uniform methods for conducting bull association work. (This program is presented in a separate paper.)
   2. Uniform methods of herd analysis for use in the various states. (This program is presented in a separate paper.)
   3. Establish a permanent record system to coordinate with that of the Division of Dairy Herd Improvement Investigations of the Bureau of Dairy Industry.

4. Pedigree service based on proved sire data and Dairy Herd Improvement Association Records. Standard recommendations concerning material to be included in pedigrees are presented.
5. Establish a standard procedure for reporting environmental conditions at least once a year for all Dairy Herd Improvement Association herds.

E8. Dairy Herd Analysis and Proved Sire Work. E. H. LOVELAND, Vermont College of Agriculture, AND R. G. CONNELLY, Virginia College of Agriculture.

Very few states have undertaken any method of long-time analysis of the breeding of herds in dairy herd improvement associations. The value of work of this type has been made readily apparent with the search for superior germ plasm undertaken in 1935 by the Bureau of Dairy Industry. The problem is to devise a system through which dairy herd improvement association figures can be studied and used by herd owners in improving the germ plasm of their herds for production factors. Some of the requirements of such a system are:

1. Reasonable accuracy.
2. Simplicity.
3. Uniformity through the country.
4. Elasticity to allow for environmental conditions and revision.
5. Continuity over a period of years, past and future.

The system concerns itself with four phases—

1. The gathering of data.
2. Permanent records.
3. Analysis of records.
4. Follow-up of analysis.

The newly organized national proved sire program and the permanent life history sheets for cows and herd sires, together with the figures obtained in the superior germ plasm study, furnish a system of gathering and making permanent records obtained. For analysis, the following three forms are recommended:

1. A form presenting the sires used in chronological order in the herd at the top of sheet, with tabulated data as to production of daughters tested, comparison with dams, and numerical difference between daughter-dam records. In the vertical columns are presented the records of daughters of each bull arranged so that a cow family can be followed through horizontally on the sheet. The quality of the record will be indicated by color comparing production with both sire and dam. From this record superior lines of both male and female germ plasm can be located and traced through succeeding generations.

2. A line chart presenting the effect of herd sires used in chronological order by averages and range of production of dams and their daughters.

3. An arrow chart for bulls on which a more detailed study is desired showing the position of production of daughters relative to that of dams.

The first chart presents the herd as a whole, its progress and location of superior cow families. The second chart presents the herd sires used and effect on both average production and range of production for either milk, test or fat, as desired. The third chart gives opportunity for more detailed study of a particular bull for desired characters.

Forms from these charts should be prepared by the Bureau of Dairy Industry for national use. The preparation of these charts should be local within the state to give opportunity for variations to meet local conditions.

Such a system should be capable of revision as experience and development makes possible, but is a foundation for a permanent system of herd analysis which, if used by breeders as a basis for selection of breeding stock, especially herd sires, will add greatly to the value of dairy herd improvement association work as a tool for genetic improvement of our dairy cattle.

The states should institute plans of following up of these analyses through breeding schools, bull associations, publicity of superior germ plasm, and other extension methods designed to acquaint dairymen with these records, what they mean, and how they can be used.

E9. Alfalfa-Molasses Silage vs. Alfalfa Hay as a Roughage for Lactating Dairy Cows. Russell E. Horwood, Upper Peninsula Sub-Station, Michigan State College.

Second cutting alfalfa, ensiled with molasses, was compared with second cutting alfalfa hay, field cured, as the sole roughage for cows in milk, in a 105-day feeding trial.

The alfalfa was cut September 23rd and 24th in the one-tenth bloom stage. Little wilting occurred due to cloudy weather. Thirty pounds of molasses diluted with three parts of water was added to each ton of chopped alfalfa silage at the bottom of the filler pipe. Twenty-three and one-half tons were placed in the silo in this manner.

In addition, two tons of unchopped alfalfa hay with molasses sprinkled over it were placed in the silo near the bottom. This was found to be even more palatable than the chopped silage. Three samples of the unchopped silage averaged 14.3 per cent grass.

The two tons of unchopped silage when packed was 12 inches in depth in the 14-foot diameter silo. Two tons of chopped silage immediately below the unchopped was 10 inches in depth.

Nine and one-half tons of alfalfa were cut at the same time and cured in the cock. This resulted in good quality hay which was fed against the alfalfa silage. Due to a lack of barn room some of this hay was fed to the main herd. This caused a shortage for the experiment, making it neces-

sary to use first cutting alfalfa of only fair quality during the last 30-day feeding period.

Four feet of spoilage was found on the surface when the silo was opened November 17th. Below this the silage was dark green in color. The temperature at the surface on November 30th was 39 degrees Fahrenheit; eight inches below the surface it was 59 degreesF., sixteen inches below 68 degrees F., and thirty-four inches below 68 degrees Fahrenheit.

Two groups of three cows each were placed on a feeding trial. The double reversal feeding system was followed using three thirty-day feeding periods with five days between each period.

One group of cows was fed 30 pounds of field cured hay, while the other group received 87 pounds of alfalfa-molasses silage per day. Each group received ground barley plus one per cent special odorless steamed bone meal and one per cent iodized salt at the following rates:

Below 20 lbs. milk— no grain	50 to 55 lbs. milk—14 lbs. grain
20 to 25 lbs. milk— 2 lbs. grain	55 to 60 " " —16 " "
25 to 30 " " — 4 " "	60 to 65 " " —18 " "
30 to 35 " " — 6 " "	65 to 70 " " —20 " "
35 to 40 " " — 8 " "	70 to 75 " " —22 " "
40 to 45 " " —10 " "	75 to 80 " " —24 " "
45 to 50 " " —12 " "	

The silage ration produced 10,483.7 pounds of 4 per cent fat corrected milk,[1] while the hay ration produced 10,173.4 pounds.

The cows on the silage ration gained 178 pounds in body weight while the cows on the hay ration gained 224 pounds during the feeding trial.

The cows on the silage ration consumed 23,490 pounds of silage and 2,950 pounds of grain. The cows on the hay ration consumed 8,100 pounds of hay and 3,105 pounds of grain.

Analysis at the start of the feeding trial showed that the silage contained 27.7 per cent dry matter and 21 per cent protein on a dry matter basis. The hay contained 86.4 per cent dry matter and 19.5 per cent protein on a dry matter basis.

Two analyses[2] of the silage for carotene content showed 24 and 21.6 gamma per gram on an air dry basis. The carotene content of two samples of butterfat produced during two different periods from the silage fed cows contained 1.5 and 0.8 mg. per kg. Two similar samples of butterfat from the hay fed cows contained 1.45 and 1.3 mg. per kg.

E10. Calf Starters Fed Dry with Limited Whole Milk. E. S. SAVAGE, Cornell University.

Bulletin 622 of the Cornell University Experiment Station, Ithaca, New York, gives the detailed work done with 76 calves on calf starters. As a

[1] Gaines & Davidson, Ill. Exp. Sta. Bul. 245.

[2] Courtesy of Dr. W. E. Krauss, Ohio Agricultural Exp. Station.

result of this work it is recommended that calves be limited to a total of 350 pounds of whole milk fed during the first seven weeks after birth. They are completely weaned from milk at seven weeks.

As soon as they will eat it they are fed all they will eat of good mixed hay with some legume in it, preferably second cutting mixed timothy and clover. In addition to the hay, as soon as they will eat it, (at about two weeks of age), they are offered all they will eat of the following mixture:

32.25	per	cent	ground yellow corn
28.00	"	"	rolled oats
10.00	"	"	wheat bran
5.00	"	"	linseed meal
3.00	"	"	white fish meal
20.00	"	"	dry skimmilk
0.50	"	"	salt
0.50	"	"	ground limestone
0.50	"	"	steamed bone meal
0.25	"	"	reinforced cod liver oil

This calf starter is fed dry in a box nailed up in the pen. A good sized box for four or five calves is 4′ long, 4″ high, and 4″ wide. The calves are full fed free choice on this mixture until they consume four pounds per day.

When the calves are about 14 weeks old they are offered some fitting ration similar to the following:

560	lbs.	corn meal or hominy
600	"	wheat bran
600	"	ground oats
200	"	linseed oil meal
20	"	steamed bone meal
20	"	salt

The calves receive no calf starter after 16 weeks. Beginning with the 17th week they get only hay, fitting ration and water. All calves have free access to water after about the 3d week. They are restricted to 4 lbs. of fitting ration per day per calf.

Since Bulletin 622 was published sixteen calves have finished a six months' trial on the same calf starter as given above. Four were fed as a check lot. Four were fed on the same mixture in pellet form, four received the same mixture in pellet form with ground oats in place of the rolled oats, and four were fed the same mixture in pellet form with ground oats in place of rolled oats, and 200 pounds of alfalfa leaf meal instead of the same amount of corn and oats.

All calves on this calf starter and these modifications have been very thrifty and have made average gains to six months of age of 1.5 pounds per day or better.

No advantage has been obtained from feeding this starter in pellet form. Pelleting makes the feed a little cleaner to handle but the calves do not seem to eat the pellets any more freely or to gain any better on them.

Other trials are in progress studying the effect of yeast in different forms. A more concentrated starter is being studied in order to get the calves to eat more at the critical period at seven and eight weeks of age.

E11. Sudan Grass and Sweet Clover as Temporary Pasture Crops.

R. A. ACKERMAN AND H. O. HENDERSON, West Virginia University.

Bluegrass pasture usually gives excellent results in the early spring when it is lush and tender, but as the season advances it ripens and dies so that it is usually necessary to supplement it with some other pasture or green feed.

At the Reymann Memorial Farms, a study has been started to determine what crops are best to use at this time. The study has thus far included sudan grass with soybeans, and sweet clover seeded with oats, and they have been compared with a good bluegrass pasture. The plots contain two acres, are run in duplicate, and are fertilized at the same rate.

Dairy cows in milk were pastured on them in numbers sufficient to keep the growth at proper height. Measurements were made by the number of pasture days, the production of milk and butterfat, and the total amount of digestible protein and total digestible nutrients produced. The time at which the pasture was available for use was also calculated in order to determine the supplementary effect of pasture.

The following table shows the average number of pasture days furnished by each pasture over a period of three years, 1933–35 inclusive, and the percentage of the pasture which was furnished before August 1 and that furnished after August 1.

PASTURE	PASTURE DAYS PER ACRE	PER CENT FURNISHED BEFORE AUG. 1	PER CENT FURNISHED AFTER AUG. 1
Bluegrass	138.9	56.3	43.7
Sudan grass (and soybeans)	95.3	.7	99.3
1st yr. sweet clover and oats	42.8	49.8	50.2
2nd yr. sweet clover	132.2	100.0	0

It will be noted that while second year sweet clover furnished almost as many pasture days as did bluegrass, it furnished them all during the months when they are least needed. The first year sweet clover furnished very few days during the season, about one-half of which was furnished by the oats with which it was seeded. Sudan grass, on the other hand, while it did not furnish quite as many pasture days as did second-year sweet clover, supplied them in the season of the year when they were most useful for supplementing the blue grass.

E12. Summer Decline in Milk Production. H. O. WALES, JAS W. LINN, AND F. W. ATKESON, Kansas State College.

A lack of normal production and a refusal of milking herds to respond to apparently normal feeds and feeding practices, in the fall of 1935, prompted a study of the Dairy Herd Improvement Association monthly summaries to determine how the level of production for this season compared with that of previous years. This study emphasized to the authors the decided decline in summer production that was being obtained on the Kansas dairy farms. Tabulations were made over a period of six years, from 1930 to 1935 inclusive, on over 5,000 cows. Curves and tables are presented, showing trends of monthly production of milk and butterfat, butterfat price per pound and feed costs. The study shows a rapid increase in production in the spring months and a more rapid decline during the summer months. The peak of production usually comes in May, and the low point in September. The lowered production in the late summer months has resulted in a higher cost of milk production throughout a greater portion of the year, and is a tremendous loss to the industry.

It is not the purpose of this paper to outline the contributing causes of the summer slump, but rather to call attention to its significance in Kansas. This situation is also probably true throughout most of the middle western states and is an important problem associated with dairy herd management.

E13. Feeding More Roughage to Dairy Cows. C. F. HUFFMAN, Michigan State College.

The trend is toward greater utilization of pasture and roughage. Roughage usually refers to feeds high in lignocellulose which are low in digestibility. According to this definition young grasses which are high in productive energy on a dry basis are not roughages.

The feeding value of roughages depends on the stage of maturity, method of preservation, palatability and phosphorus content.

The first deficiency of a ration of alfalfa hay alone is productive energy. Experiments indicate that such a ration can produce about 150 pounds of butterfat per 305 day lactation. The addition of cereal grains to such a ration to meet the energy requirement results in the production of 400 to 500 pounds of butterfat per year. When alfalfa hay is worth $6.00 per ton and corn is $30.00 per ton the feed cost per pound of butterfat is about the same at various levels of production. When corn is fed and is worth less than $30.00 per ton, the feed cost per pound of butterfat is less at higher levels of production than at low level of production when alfalfa alone is fed.

In regions where the phosphorus content of alfalfa hay is below 0.2 per cent, the home grown ration should be supplemented with a phosphorus supplement.

Suggestions for feeding alfalfa hay, corn silage and cereal grains:

Feeding Schedule for 1200 lb. Holstein

MILK PER DAY LBS.	ALFALFA HAY LBS.	SILAGE LBS.	LBS. CORN	BONE MEAL OZ.
20 lbs. or less	12	55	.....	.....
25	14	50	2	.....
30	16	45	4	2
35	18	40	5	2
40	20	35	7	2
45	24	25	9	2
50	25	20	10	3
55	28	10	12	3
60	30	.....	15	4

Feeding Schedule for 1000 lb. Jersey or Guernsey

MILK PER DAY LBS.	ALFALFA HAY LBS.	SILAGE LBS.	CORN LBS.	BONE MEAL OZ.
12	12	45	0	0
15	15	35	1.0	0
20	15	35	3.0	0
25	15	35	5.0	0
30	16	30	8.0	2
35	16	25	11.5	2
40	20	15	12.5	3
45	20	15	15.0	3
50	24	.....	18.5	3

This system of feeding roughage and grain makes possible the efficient use of alfalfa, corn silage and corn. This system would probably work with a mixed hay of alfalfa and grass in place of straight alfalfa.

E14. 4-H Dairy Club Work as a Dairy Extension Project. JOE NAGEOTTE, Pennsylvania State College.

The primry aim of 4–H dairy club work is to help farm boys and girls develop dairy herds, to instruct them in the most up to date methods of breeding, developing, and managing these herds, and especially to help them build broader, happier and fuller lives. In addition we dairymen can help develop the above program and bring about as many improved practices as any other dairy project if we put the same amount of energy and thought into it.

To aid in reaching the primary goal and to further increase the adoption of improved dairy practices, we make the following suggestions relative to the subject matter phase of the work:

1. The organizational and recreational responsibilities of the program should be assumed wholly by the club departments. The club and dairy departments should assume jointly the responsibilities of, promotion, con-

tests, and personal contacts. Calf standards and the teaching of subject matter should be assumed wholly by the dairy extension departments.

2. A dairy extension worker should explain the 4–H dairy project, its plan, and the possible results at a preliminary meeting of prospective club members and their parents.

3. All calves and home herds should be shown by tests or certification to be free of Bang's Disease and tuberculosis before the project is started.

4. All calves being used should be approved by a dairy extension worker. All calves should measure up to or exceed a definite State standard for apparent inheritance for production, and the calves should be suitable representatives of their breed as to type.

5. The project should be carried on for at least three years.

6. Suitable subject matter instruction should be prepared, and if possible presented by the dairy extension workers. This subject matter should be so timed that club members can apply this instruction to their calves.

7. An opportunity should be given to every club member to show his calf at a community round-up where the club members are scored on how well they have applied the instructions given them. The best exhibits from these community shows should be taken to a county or regional show and the best from these to a State show.

8. All dairy club contests should be so conducted that they will be a measure of how effectively the instructions can be applied by the club member.

9. Personal visits should follow if the club members and their parents wish to apply new practices to the home herd and if such visits are necessary for a successful application. It must be remembered that every club project is looked on by the community as a result demonstration.

10. In all cases, the dairy extension department should act as an advisor and not as a dictator. This work is educational and not regulatory.

11. Parents should be urged to attend all meetings where subject matter instructions are given.

12. The ground work should be laid so that as the club members mature, they would take up the adult dairy extension projects.

E15. 4-H Club Junior Bull Rings. M. L. FLACK, University of Nebraska.

It is an established fact that a great many farm boys and girls are enrolled every year in pure-bred animal projects but only a few of them ever develop pure-bred herds of improved types of live stock. The main reason for this is, that although a boy begins his club work with a good pure-bred female, no provision is made for him to mate her with a male of suitable quality. Often, the only pure-bred animal on the farm is the boy's club heifer and obviously it would not pay to own a pure-bred bull. Unless a farmer is interested in dairying and making that his major enterprise, he

does not care to keep on the farm a good dairy bull and certainly he does not care to invest a lot of money in a sire of the desired type and production. So it follows that many of the club members have had to use inferior bulls to which they breed their pure-bred heifers.

This condition of affairs is more serious in the middlewest than it is farther east because here greater numbers of farmers have herds that are greatly mixed or just fair to common grades. In some counties only a few men have pure-bred herds. Often in Nebraska 4-H Club boys and girls are great distances from owners of sires equally as good or better than the club cows.

A good farmer when planning the development of a pure-bred dairy herd, places the greatest emphasis upon the selection of a sire, which is the correct thing to do since a good sire is half the herd. This being the rule with adults, why should it not also apply to 4-H Club members who are going to be our breeders in the near future.

In order to change this existing condition in pure-bred dairy club work, the extension dairymen working with several of the county agents in 1932 developed a plan which partly provides for the lack of suitable sires. With this apparent need in mind, several 4-H Junior Bull Rings were organized in various counties in Nebraska under the supervision of the county agents, the extension dairymen, and advisory committee composed of the club members' parents. By means of these rings the services of bulls of better type and from higher producing ancestry are made available to both past and present 4-H Club members.

The rings are divided into blocks; a bull placed in each block so that every member will be within reasonable distance of a bull.

The bulls are purchased and owned cooperatively by the members. In order to save money, the bulls now in use were purchased as calves and grown out by the members.

It is required that the bulls be of superior conformation, free of disease and from high producing ancestry from dams producing not less than 500 pounds butter fat at maturity. All bulls must be approved by the state dairy extension specialist.

Aside from the assessment for the purchase of bulls, each member pays a membership fee. This money is used for moving bulls, paying veterinary bills, and other expenses arising in such an organization. In case a member wishes to withdraw he is paid a reasonable compensation for his investment in the bulls.

The success of such an organization depends largely upon the care and management of the bulls. So in order to safeguard the investments of the members the following rules and regulations have been found necessary.

1. The board of directors shall designate the places for keeping the bulls and arrange in each block a suitable bull pen and equipment necessary for

the safety of the keeper and for the health of the bull. All bulls shall be ringed. Each block director shall see to it that the bull in his territory is getting the correct kind of feed and the kind of care that will keep him in a strong, vigorous, healthy condition.

2. The bull shall not be permitted to run with the herd.

3. The bull shall not be allowed loose with any cow and shall not serve over two cows in one day, nor more than seven in a week.

4. The herd where bull is kept must be free of tuberculosis and Bang's disease.

5. All bulls must be purchased subject to the T. B. and Bang's test.

6. The custodian in return for care and feed shall have free service for his herd.

7. A nominal service fee shall be charged non-members of the club. No outside cows may be bred without permission of the board of directors.

8. The club bulls shall be inspected at least twice a year by a committee appointed by the directors and a report made as to their health, condition, and breeding ability.

9. No bull may be sold or disposed of without the consent of the board of directors, advisory committee, dairy specialist and county agent.

10. In case any bull is not receiving proper care and management, he shall be moved to a more desirable location by the board of directors.

11. A bull may be bought as a calf but shall not be used for service until he is one year old.

12. Every two years the bull in each block shall be shifted in the numerical order of the blocks, unless otherwise arranged. The directors shall arrange for the disposition of the bulls which have made a complete round of all the blocks.

In order to retain interest in the rings after they are well started, it has been found advisable to plan all-day tours, which include picnic dinners. One tour was for the purpose of dehorning all bulls, another was held in order to ring all bulls.

The county fair boards cooperate by providing a class for these bulls at the local county fairs with suitable prizes—a good way to add community interest in the project. Too, there is a place provided for them as a cooperative exhibit at the fairs. The Junior Sire Contest which parallels the Purebred Sire Contest stimulates interest.

One may readily realize that it is possible for these sire rings to become rather large organizations, since in Hamilton County the fourteen bulls are being used in approximately forty herds. The herds here are rather small and it is not practical for individual farmers to own bulls. Although time does not yet permit comparisons of production in offspring, yet there is a very marked improvement in the type.

E16. Dairy Projects for Older Boys. EARL N. SHULTZ, Iowa State College.

Census figures for 1930 showed that there were 3,000,000 more people on farms in the United States than there would have been under normal conditions. Approximately 2,000,000 of this number were young people between the ages of 16 and 25 years. This increase in rural population has continued up to 1935.

This increase has been due to the lack of employment in cities and because many farm young people have been unable to go to college. These young folks need and desire further educational opportunities.

Recently in a number of states rural young people have formed community and county-wide organizations for educational and recreational purposes. Extension workers have taken steps to plan projects for these young folks who are out of school and are reaching the upper age limits of 4-H Club work.

A study was made of the various dairy projects carried on by a number of states for older boys. A wide variety of projects were found. New Hampshire, California, and the province of Ontario, Canada, have divided the club work at 15 years. Boys above this age must carry more advanced type of work than those younger. Kentucky has formed Utopia clubs for rural young people 19 to 26 years of age. Members are elected to the clubs and must carry on one or more projects. The dairy project requires the maintenance of a dairy herd of not less than five females, the growing of alfalfa, conducting a pasture demonstration and the keeping of monthly feed and milk production records.

Minnesota has developed a farm partnership plan whereby father and son make a partnership agreement giving the son a share of the farm income. Nebraska has a junior bull ring plan for older boys who have developed small herds through club work. Iowa has given training to older boys to prepare them for leaders of local clubs.

The study of these plans and the comments of specialists working with them can be summarized as follows:

1. The project should not take from the father's income but should supplement the income from the farm.
2. It should be broad, including instruction in the historic and economic phases.
3. There should be actual work on a specific project as learning comes through activity.
4. The project should develop group action.
5. The project should cover a long period of time, from 3 to 5 years preferably.
6. Competitive features should be avoided but some form of recognition should be given.
7. Emphasis should be put on training in management and finance.

A project is outlined which will be carried out in Iowa during the coming year.

ABSTRACT

E17. The 4-H Classification at the National Dairy Show. D. M. SEATH, Kansas State College.

Special recognition by the National Dairy Show of outstanding 4-H dairy cows is in prospect in the near future. Whenever classes are provided for 4-H animals it will be for cows in production according to the management of the show. Inasmuch as this year's show will be held at Dallas, Texas, which is relatively uncentral in location, such classes will not be included this year, however.

Dairy judging and demonstration contests will comprise the major 4-H activities at this year's National Dairy Show. For the first time Brown Swiss cattle will be judged in the junior contest. In each of the Ayrshire, Guernsey, Holstein, Jersey, and Brown Swiss breeds there shall be one ring of cows and one ring of heifers.

An additional demonstration team from each state will be eligible to compete in the demonstration contest according to a new plan inaugurated this year. This will allow each state to enter a team in each of the following classes: A—On production; B—On consumption; C—On manufacturing.

A significant change was made in the eligibility rule pertaining to winners of previous trips. As it now stands a 4-H member could represent his state on a demonstration team one year and still be eligible to represent his state on a judging team the next year. Likewise competition on a 4-H judging team would not bar him from future participation at the National Dairy Show on a demonstration team.

Additional money has been allowed to the committee in charge of the 4-H department of the National Dairy Show for conducting their department in 1936. Rules for the various contests and the plan for assisting in defraying expenses of contestants on an equitable basis will be outlined in the premium book. Advance copies of these plans either have been sent or will be sent within a short time to all of the state 4-H Club leaders. The writer represented the Extension Section of the American Dairy Science Association on the committee that drew up this year's plans.

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